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EXPLORATIONS IN MONGOLIA: A REVIEW OF THE CENTRAL ASIATIC EXPEDITIONS OF THE AMERICAN MUSEUM OF NATURAL HISTORY

Roy Chapman Andrews, A.M., Sc.D., Leader

The Second "Asia Lecture."

Read at the Meeting of the Society, 8 November 1926.

IT is obviously impossible in a single lecture to give an adequate account of our five years' work in Mongolia. I can do no more than present a kaleidoscopic picture of the expedition, touching briefly upon the organization, methods of work, and the most important results in the several branches of science represented.

Twenty-six years ago, Professor Henry Fairfield Osborn, President of the American Museum of Natural History, predicted that the high plateau of Central Asia would prove to be the chief theatre of mammalian evolution and distribution. He believed that there would be found the ancestral types of north mammalian life from which waves radiated to the continents of Europe and North America. But this theory was based almost entirely upon inductive reasoning. He had but few facts at his command.

After ten years of zoological work in various parts of Asia, plans had gradually taken shape in my mind to test the truth of Professor Osborn's theory by reconstructing the physiography, climatic conditions, vegetation, and animal life of the Central Asian plateau in successive geological periods, so far as it was possible to do.

I realized that we could obtain satisfactory results only by bringing to bear upon the problem every branch of science which could assist in its solution. A group of highly trained specialists must be taken into the field *together*. Thus the work of each man could assist all the others.

The value of such correlated work was demonstrated continually. As we sat in the mess tent at night discussing the day's work, it was most interesting to see how puzzling situations in geology would be clarified by the palæontologist; how the topographer brought out important features which gave the key to physiographic difficulties; and how the palæontologist would be assisted by the palæobotanist or geologist in

solving stratigraphic problems. Therefore I should like to emphasize again, that the work correlated *in the field* was the basic plan of the expedition.

I believe that this is the first expedition of such magnitude that has employed these methods. I am willing to predict, moreover, that it will become the recognized type of scientific exploration of the future.

It was obvious that the two great essentials for a successful attack upon Central Asia were sufficient time and money. Five years, which were later extended to eight, and a fund of about 400,000 gold dollars were required. Although the expedition is under the auspices of the American Museum of Natural History, the Museum could advance only a small part of the finances besides contributing the services of many members of its scientific staff. It became necessary to interest private individuals, and it is significant that the contributions came from twenty-six states of the Union. The money was given freely for the cause of science with no thought of material return.

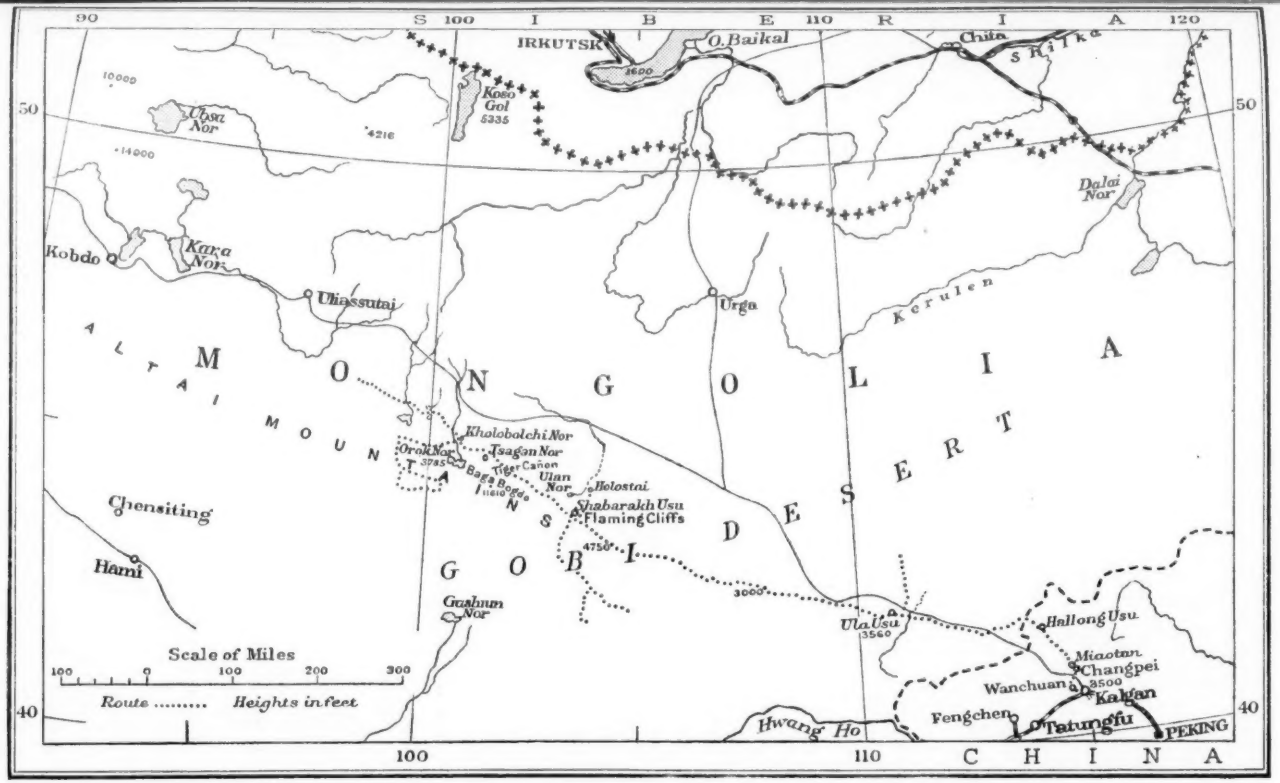
There are many reasons why Mongolia has remained comparatively unknown scientifically. First is its isolation in the heart of a continent, its vast size and slow transportation. Until we began work only camels were used in the western Gobi Desert. The average speed of a camel caravan on a long march is but 10 miles a day.

Second, the severe climate is an important difficulty. During the winter the temperature drops to 40 or 50 degrees below zero, and the summer is very short. Effective scientific work can be done in Mongolia only from April 1 to October 1.

Third, in the Gobi Desert, which occupies a large part of Mongolia, food and water are so scarce that very careful preparations must be made for an extensive expedition.

I believed that all the physical difficulties could be solved by some means of rapid transportation. Motor cars appeared to be the answer. But when it was announced that we intended to explore the uttermost reaches of the Gobi Desert with automobiles, we were quite frankly called fools. Nevertheless, as far as we could discover, the principal reason advanced by our critics as to why it was not practical was merely that it never had been done. With a complete assortment of spare parts and two expert motor engineers such as McKenzie Young and Norman Lovell, I could see no reason why it would not be possible to take out cars almost anywhere in the Gobi Desert. The success of the motor transport is shown by the fact that in the first two seasons with the same fleet we travelled 10,000 miles in a region where there were no roads, and that at the end the cars were sold as they stood, with no repairs, for more than they cost in America when new.

A camel caravan averages 10 miles a day, but in the motors we could do 100 miles daily. Thus the expedition had the advantage of speed over



Sketch-map of Mongolia to show the route of Dr. Andrews' Central Asiatic Expedition

the previous explorers who had crossed the desert with camels only and we were able to do virtually ten years of work in a single season.

Moreover, our expedition has had the somewhat unexpected result of opening Western Mongolia to motor transport. Commerce follows closely upon the heels of exploration, and as soon as we had returned from the first expedition, merchants came to us to ask how they could reach various interior trading stations to bring out valuable cargoes of furs and other commodities. Now there are about one hundred cars running through parts of Mongolia where until we came the only transport was by camel caravan.

We were offered discouragements from the scientific standpoint quite as much as in the use of motors. Our friends called our attention to the fact that, with the single exception of a " rhinoceros " tooth found by Obruchev in 1909, no fossils ever had been discovered in Mongolia. Nevertheless there were reasons to believe that a great deal of the previous work had been too much political or economic and too little scientific. I felt sure that, if we took a group of highly trained experts who had only science in view into the Gobi Desert, results would be forthcoming.

The truth of the prediction was quickly demonstrated. Four days after starting in 1922 we discovered that the main trail between Kalgan and Urga, which has been travelled by thousands of persons, including several geologists, runs directly through three rich fossil beds—one Oligocene, one Eocene, and one Cretaceous. Moreover, the expeditions of 1922, 1923, and 1925 not only substantially verified Osborn's prediction but also "revealed a new volume in the life-history of the Earth."

Although the first two field seasons were primarily devoted to palæontology, the third summer saw the beginning of work in archæology, which will occupy us largely in the future. The theory that Central Asia was the possible home of the Tertiary ancestors of man, namely those of the Eolithic or Dawn-stone Age, holds most alluring prospects for the scientific explorer.

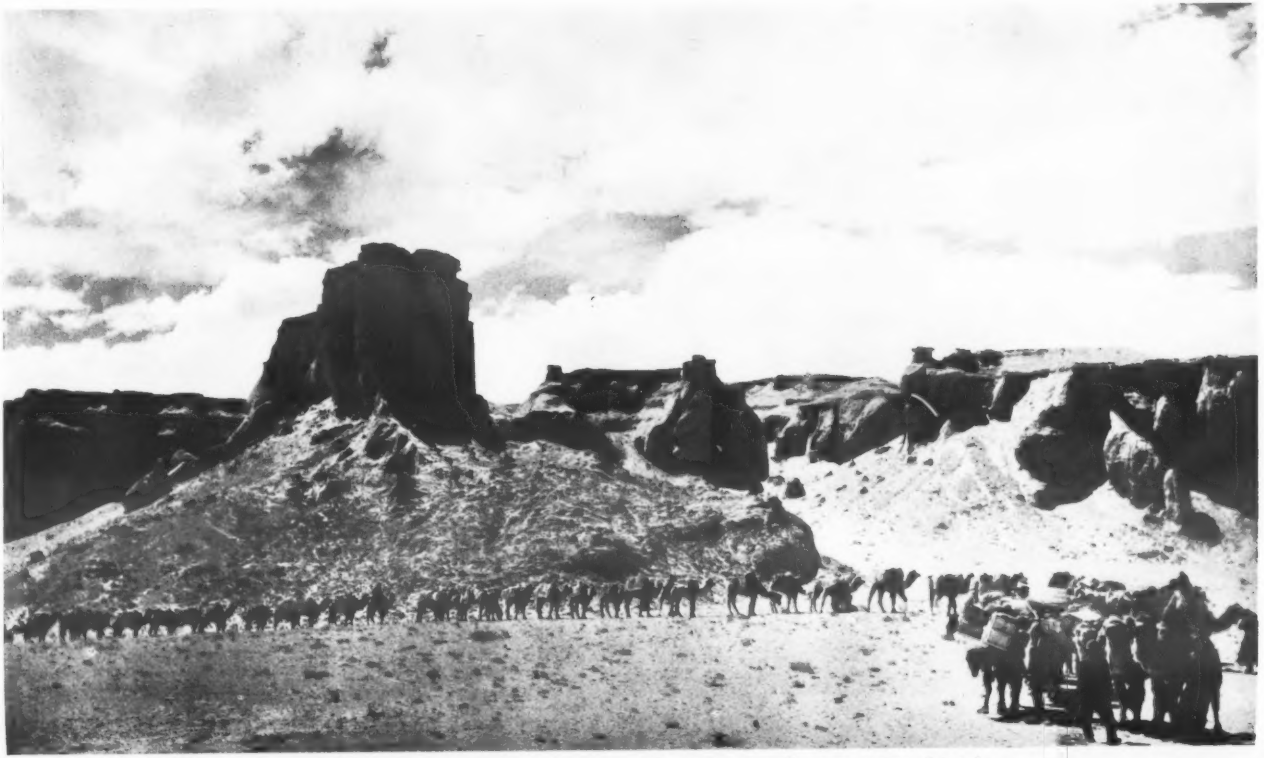
From the inception of the expedition the study of human ancestry has been our ultimate purpose, and the single season's work of 1925 yielded such rich returns that we look forward with increasing eagerness to furthering the explorations.

Organization.

The expedition comprises the following branches of science: palæontology, geology, palæobotany, archæology, topography and zoology, the latter including mammalogy, herpetology, and ichthyology. The 1925 expedition totalled forty men. The foreign staff included twelve Americans and two British; and in the native staff there were twenty-six Chinese and Mongol assistants, some of them being highly trained experts.

I should like to make it clear that the success of our work does not

1. *The Caravan of* 125 *Camels on its way to the "Flaming Cliffs"*



2. *The "Flaming Cliffs," where the Dinosaurs' eggs were found*

rest with me as the leader or with any one man. The credit should be equally divided among all the members of the staff, for each man did his work superlatively well. The expedition was a machine which could not have functioned properly unless every part had worked smoothly. I do not believe that a more loyal, efficient, or devoted staff ever has gone into the field on any expedition.

The transport consisted of seven Dodge Bros. motor cars and a supporting caravan of 125 camels. The latter acted as a movable base and with supplies of gasoline and food for five months was sent many weeks in advance of the motor party.

With so many branches of science represented it was highly improbable that all the men could find work in the same place at the same time. Therefore the expedition was divided into four units, each with a car complete with its own driver, interpreter, assistants, and camp gear. Any unit could leave the base camp and maintain itself independently for several weeks if necessary. As a matter of fact, the expedition was almost continually divided, except when we made long marches to new localities.

Our Mongolian explorations have been referred to as a *de luxe* expedition because it provided the maximum of camp comforts. I may say, however, that there was not one item of equipment that did not have a necessary function. We had in the field a group of men who worked at high tension with never a rest for five months. An army cannot fight unless it is well fed. Neither could our men have accomplished what I expected of them unless they were kept physically fit. I do not believe in hardships if they can be avoided, for they lessen effectiveness.

It became evident that if there was to be no loss of time and effort the first season must be strictly a *reconnaissance.* It must make a general survey of many thousands of miles of country to locate and appraise the value for our especial purposes of new regions without attempting exhaustive work in any of them. The next year could then be one of intensive study, and the amount of time to be devoted to each locality carefully planned in advance. Such intensive work would require a different staff from that for rapid *reconnaissance.* As an example, in the summer of 1922 Mr. Walter Granger was the only palæontologist. On the next expedition he was reinforced by three other expert collectors and two highly trained Chinese assistants, because such rich fossil beds had been discovered that we needed a large staff for their rapid exploration. We planned in advance the number of days or weeks that could be devoted to each locality, and with one exception maintained the schedule throughout the summer. This method of *reconnaissance* followed by intensive work is the only effective way to avoid loss of time and effort.

2. The "Flaming Cliffs," where the Dinosaurs' eggs were found

Political Difficulties.

Although the physical difficulties of maintaining a large expedition in such a remote region are great, they become insignificant in comparison with the political obstacles which must be overcome before one can even begin work. Mongolia is a theatre of contending politics, and each year it has been more and more difficult to steer a safe path for the expedition between the political rocks which bar the way to the great open spaces of the Gobi Desert.

The past summer we have not been able to go into the field at all, due to the civil war in China which raged along the Mongolian frontier. It marooned us in Peking, from which we made three ineffectual and highly dangerous attempts to find a way through the fighting lines. We have lost a season's work and many thousands of dollars, but it appears probable that we can get away next summer to continue our explorations in the western Gobi.

Topography.

The existing maps of Mongolia are nearly all based upon the Russian map, which is very unreliable. Apparently much of it was prepared from native information, which is proverbially bad. Mountains appear where there are no mountains. Many of the largest caravan trails are omitted, and important natural features are incorrectly located. As an instance, we camped near Ulan Nor, which is indicated on the Russian map as a large lake. We found that the so-called "large lake" was a small and at that time a dry bed, and that its map position was more than 50 miles in error.

It was evident, therefore, that careful topographical work was a necessity. We were fortunate in obtaining the services of Major L. B. Roberts, U.S.A. R., one of the most expert topographers in America. Major Roberts was assisted by Lieut. F. B. Butler, Corps of Engineers, U.S.A., and Lieut. H. O. Robinson, 1st Loyal North Lancashire Regt.

Major Roberts was confronted with a most difficult problem: to do actual survey work, carrying his levels from a known point, and still maintain touch with the rapidly moving main fleet of motor cars. No man of less energy or initiative could have carried out such a route map successfully. He was offered the usual discouragements, and was told that in a flat country where natural objects were almost non-existent, it was impossible to do a rapid survey. Major Roberts developed the ingenious method of using motor cars as stadia rods. The height of the hub, fender, radiator, and windshield were known, and these points were sufficient when it is realized that the length of sight was from 1 to 2 miles. The distance was taken by speedometer, which had been carefully rated. Regarding the methods of mapping, Lieut. Butler reports substantially as follows:

3. *Wind-eroded red sandstone cliffs on the edge of fossiliferous basin*

4. *The sand-dune belt north of the Eastern Altai*

"The topographic work done during the field season of the expedition was divided as follows: Route maps were made with plane-table and telescopic alidade; the elevations were carried by vertical angle; the scale used was 1 : 200,000, and the contour interval was 50 feet. The distance was measured either by stadia or speedometer on the topographer's car. On compass reconnaissances bearings were read with a prismatic compass, and elevations were determined by aneroid barometer. Distance was measured by speedometer.

"In area surveys the scale used was 1 : 20,000, and the contour interval was 1, 10, and 20 feet.

"The most important piece of work undertaken by the topographic party was the execution of a route survey of the entire season's journey. It was necessary that this survey should be based on an established datum, and consequently efforts were made to carry the line and levels from the Kalgan railroad station. This was accomplished in the face of certain difficulties. Before the rest of the party took the field, the topographers had run the line up and over the pass which breaks from China on to the Mongolian plateau, and had reached a point 36 miles beyond Kalgan. Barometers were not used on the main route survey at any time during the season, and this survey is the first to be made in the area covered, wherein an attempt was made to carry line levels. For the first part of the work, the run of 36 miles from Kalgan to Miaotan on the plateau, stadia rods were used.

"For the route work, Major Roberts decided to use a plane-table and Gurley telescopic alidade. The Baldwin solar chart was depended upon for orientation, and the compass resorted to only on the infrequent occasions when clouds obscured the sun.

"To enable us to cover the day's run and at the same time not to reduce the anticipated rate of travel, two other cars were detailed to work in conjunction with the topographers, and were used as stadia rods on foresight and backsight stations. While the backsight was being taken on one of these cars, the other would run on and pick up a point for foresight. The backsight having been completed, the rear car would be signalled, run forward, and, while the foresight was being taken pass us and be ready in turn to establish a foresight. The average day's run with this system was 58 miles, and the maximum 73·4 miles. A total of 1040 miles of such line was mapped.

"The levels were carried by the table itself, and in many of the set-ups we had level readings. Usually, it was possible to step the vertical difference with the stadia hairs, and only rarely was recourse had to the Beaman arc. Distance was taken from the speedometer on the topographer's car, which had been carefully rated prior to taking the field. During the field work it was checked against courses, from 15 to 20 miles long, which had been laid out by stadia. The use of the speedometer in measuring the distance was more or less an experiment, but the

4. The sand-dune belt north of the Eastern Altai

manner in which the traverse closed in on the control points fully justified the confidence in its use.

"Naturally, since the differences in elevation were frequently a function of the distance run, the question of the accuracy and suitability of the speedometer distance was one of double importance. In certain instances, where the nature of the ground was such as to cause an excessive error to arise from the use of the speedometer, the strip would be crossed by using the stadia. Sights as long as 25 miles were used in locating mountains and other features adjacent to the line.

"To one who has not worked with this or similar methods, the value of such a reconnaissance no doubt seems questionable. The results of this year's work prove the system sound, however, and possible of wide development. In addition to the check afforded by closure or control points, there were interesting opportunities to intersect on distant prominent mountain peaks from various points. The invariable small triangle of error was a constant check on distance and orientation of the baseline. In addition to barometer comparisons, a check on line-levels was afforded by vertical angles read to these peaks from various stations along the route when possible.

"The second type of route reconnaissance by compass was not controlled save by closure on the starting-point. These reconnaissances over large areas, however, and the data obtained, will be valuable in revising and expanding such maps of Mongolia as exist.

"On this type of reconnaissance no field sketches were made, but full notes were kept, together with detailed remarks, and the sketch was worked up upon the return to the base camp. The total lineal distance covered by this method is over 950 miles.

"The area surveys, four in number, represent type formations. They will be of considerable value as text-book studies, and two of them will, in addition, be of great importance in showing the setting of valuable palæontological discoveries. In this series of maps is included one made near Hallong Usu of typical ridge and vale topography in the grassland belt. The second sheet, made at Ula Usu, shows upland and badland escarpment topography developed on later sediments, including typical wind-scour hollows on the peneplane. The third sheet, made at Shabarakh Usu, shows typical upland and escarpment with local badland development and a sand-obstructed valley. The fourth sheet, made at Tsagan Nor, shows a typical desert lake with several well-defined ancient beach-lines marking successive stages in a long history of fluctuating levels. These area surveys were all done by stadia. No control was laid out save in the case of the largest sheet, the lake survey. In this instance the present shoreline was triangulated and flagged. Incidentally, in making this sheet 1-foot contours were used to determine accurately ancient lake-levels. The four sheets mentioned above totalled 78 square miles of area survey.

" Latitude was determined by observation of Polaris off the meridian, the hour-angle computed, and correction applied. For time and longitude, the equal-altitude method was used, both sun and stars being observed. We carried with us three Hamilton chronometers: one was a No. 950 (watch movement), and two were torpedo-boat type clocks. It had been hoped to have radio service as we went along, but this was impossible once we were in Outer Mongolia and under the control of the Mongolia Government. Naturally, therefore, time, upon which all the locations ultimately depended, was a weak factor. Travelling in motor cars as we did, and covering the distance in a day that we had to, with cross-country going all the way, the chronometers were subjected to frightful conditions. To offset all this, however, certain stations were occupied for long stretches at a time, and the rating of the clocks could be determined by observation over these periods.

" Likewise, on the run back many of the original stations could be reoccupied after even a longer stretch of time, so that excellent field ratings were obtained. From the last of such observation to the final check-in and rating upon the return to Peking a minimum of time elapsed, so that the over-all and intermediate rate has been established accurately. The error, as computed from the rates determined in the field, coincided in a gratifying manner with the compared error as found by radio check in Peking. The rate for the three-week period following our return made a smooth curve with the plotted field rates.

" Several times each day magnetic north was plotted on the route field sheet, the solar chart being used to establish the meridian. Establishing meridian in such a way was sufficiently accurate to be commensurate with the compass needle used. It is interesting to note that the Eastern Hemisphere agonic line was crossed. Much local attraction was detected and many reversals recorded, all of which made us appreciate the solar chart as our most valuable aid.

" An instrument that gave excellent results was the so-called ' Swedish Barometer ' (Paulin System). We found it much better than the ordinary aneroid."

Palæontology.

Since the main object of the expedition was to test the theory of Central Asia as the chief theatre of mammalian evolution and distribution, palæontology assumed the most important *rôle* in our work during the seasons 1922–1923. In 1925 archæology was strongly emphasized, and it will divide the honours with palæontology in future expeditions.

I shall not attempt even to review the many important palæontological discoveries, but will present only a brief summary of the broader aspects of our work. Professor Osborn has remarked that " these discoveries have established Mongolia as a treasure-house of the life-history of the Earth from the close of the Jurassic time onward to the close of the

Pleistocene time, *revealing especially the hitherto unknown high continental life of Cretaceous and Tertiary times.* Consequently the outstanding geologic discovery of the expedition is, first, that Gobia since Jurassic time has been a central Asiatic continent extremely favourable to the evolution of reptiles, mammals, insects, and plants hitherto known only along the Cretaceous shorelines of Europe and the Cretaceous sea-borders of the centre of America; and, second, that this now terribly desert region, traversed by the gazelle and the wild ass, was certainly luxuriant with life throughout Cretaceous and Tertiary time, sparsely forested, with limited rain supply like the high-plateau regions of Africa to-day.

"These upland conditions of Mesozoic and Cænozoic time, also favourable to the origin of the human race itself, led to the further generalization by the writer on returning from Iren Dabasu in 1923, that the ancestors of man occupied this region during Cænozoic time and are likely to demonstrate the central Asiatic theory of human origin.

"The expeditions, . . . encircling in 1922, 1923, and 1925 the entire Gobi district in a 3000-mile radius, discovered no less than 23 distinct geological formations extending downwards from Lower Pleistocene time into Lower Cretaceous and Upper Jurassic."

The palæontological work of the expedition "revealed the high central Asiatic plateau as the home of most of the terrestrial dinosaurian reptiles of Upper Jurassic and of Cretaceous time. In brief, these discoveries establish Mongolia as a chief centre of northern terrestrial life-history from the close of Jurassic time onwards to the very close of Pleistocene time."

Of the several thousand fossil specimens obtained by the expedition the seven Cretaceous mammal skulls found at Shabarakh Usu certainly are among the most important from the standpoint of pure science. Drs. W. K. Gregory and C. G. Simpson, who have just completed an exhaustive study of the tiny skulls, conclude that

(1) The Palæocene and Eocene insectivores and oxyclænid Credonts, taken collectively, represent survivors of an earlier insectivore-creodont stock, examples of which have now been discovered in Mongolia.

(2) The discovery of these earliest of definite placental mammals in Mongolia furnishes some support of the hypothesis that Central Asia was the homeland of the radiation of the placental mammals as of a higher class than the marsupiala and monotremes.

(3) The Mongolian Cretaceous mammals stand between the Jurassic pantotherians and the Palæocene placentals, both in time and in dental structure, but are somewhat nearer to the latter.

The discovery of the now famous dinosaur eggs created a surprising popular interest in the expedition. Also from the same sand-swept dinosaurian breeding-grounds of Middle Cretaceous time some seventy-five beautifully preserved skulls and fourteen skeletons of the ancestral

5. *Alluvial fan on north slope of Eastern Altai, and peak Boga Bogdo on right at head of "Tiger Canyon"*

6. *From the slopes of Boga Bogdo, looking across mouth of the Canyon to Tsagan Nor*

Protoceratops were removed. These present an unrivalled series showing every stage of growth and development from the newly hatched baby dinosaur to old adults.

The skull and parts of the skeleton of the giant ***Baluchitherium*** is one of our most spectacular discoveries. However, the magnificent series of Titanotheres and the ancestral types of the Pecora, Rhinoceroses, Notungulates, Rodents, and Carnivora must rank as equally important if of less popular interest. As Professor Osborn has remarked:

"The scientific staff of the expedition, between the years 1922 and 1925, has interpreted one of the most desert regions of the entire world with the twin sciences Palæontology and Geology, and the wilderness of Mongolia now blossoms forth with its glorious story of prehistoric life, as the homeland of the greater number of known terrestrial vertebrates."

Archæology.

For many years the theory that Asia was the region in which mankind originated has been held by the most eminent authorities. But with the continued discovery of primitive human or anthropoid types in Europe and to a less extent in Africa a tendency has developed to regard either of these two countries as a possible homeland for the human race.

There is not time nor is this the place in which to review or discuss the evidence for or against these various hypotheses. In every case the matter is still one of theory. There are not sufficient connected facts to warrant definite statements. If the problem is ever solved it can only be by continued exploration throughout the world.

The expedition under my leadership is endeavouring to do its bit in this great work by devoting its energies to the high plateau of Central Asia. However, we are not trying to *prove* this region to be the home of primitive man. We are testing a theory and have approached the question with open minds in a scientific spirit. To discover the truth is our only object.

Although the Central Asian plateau is indicated as the place of man's origin by a mass of theoretical evidence, it is only in the last decade that systematic work in the realm of prehistoric archæology has been undertaken there. It is a vast region, difficult of access, and it is doubtful if it can ever be as thoroughly explored archæologically as is Europe to-day.

Nevertheless, rich results have rewarded the very beginning of its investigation. In 1923, the Jesuits Père Teilhard de Chardin and Père Licent discovered abundant evidences of Palæolithic man in extensive deposits of Mousterian implements at three different localities on the edge of the Ordos desert. Previous to this, Dr. J. G. Andersson had traced a widespread Neolithic and pre-Chinese culture in various parts of China proper.

6. *From the slopes of Baga Bogdo, looking across mouth of the Canyon to Tsagan Nor*

Our own work was first conducted in the Gobi Desert of Central Mongolia and was in the nature of a reconnaissance. In this paper I should like to present a brief review of what we have found.

Because caves and rock shelters, such as are abundantly present in Europe, are virtually non-existent in Mongolia, archæological work there is particularly difficult. Nevertheless, almost everywhere along the 1000 miles of the expedition's route from near Kalgan to the outlying ranges of the Altai Mountains we discovered more or less superficial traces of one or two prehistoric cultures. In sight of the Altai, where workable artifact materials such as jasper, chalcedony, and agate were abundant, evidences of long-standing occupation became more and more apparent.

Mr. Nelson, our archæologist, reports in substance as follows: The bulk of the archæological remains still lay scattered for the most part on the geologically ancient land surfaces, out of which they could not have weathered; but the types of things occurring were sufficiently differentiated to be distinguished as belonging to a succession of cultural horizons, some of which had ranged practically over the entire territory covered by the expedition. Yet in seven widely separated localities, the remains of two of these cultures, deeply embedded in old stratified wind deposits, were discovered.

In attempting to differentiate the data, there is no choice at present but to follow the European systems of classification and terminology. All told, five cultural horizons, not including the living Mongols, were found in the Gobi Desert and its borders. I will describe them briefly, proceeding from the recent to the most ancient.

Metallic.—In the grasslands of North Central Mongolia as well as in certain parts of the desert monuments consisting of rectangular and circular rock enclosures, from 3 to 150 feet across, are fairly numerous. Investigation proved most of these to be burial-places. Near these graves and obviously associated with them we frequently discovered pictographs pecked on the face of the rock. These are easily recognized as delineations of human beings, camels, horses, and cattle, as well as stag, antelope, ibex, and mountain sheep, some of which game animals are now absent from certain of the localities under consideration.

Petroglyphs of this type usually belong to the Stone Age; yet there were never any stone artifacts lying about near either the rock pictures or the burial structures. Although we dug into several graves and found skeletal remains of a brachycephalic people, nothing but bones was discovered until the end of the summer. Then a grave was opened in which lay a skeleton with its head upon a saddle, strangely like the American army saddle known as the McClellan; also there were bows and arrows tipped with iron, bits of fabric, and iron saddle trimmings. The meagre data we obtained do not warrant any precise conclusions about this interesting culture. It seems probable, however, that it is an expansion of the remarkable mound culture of Bronze and Iron Age

7. Looking south towards Boga Bogdo in cloud, from the mouth of "Tiger Canyon"

8. *The home of the Dune Dwellers near "Flaming Cliffs"*

times uncovered by Russian investigation in the Upper Yenesei country. As such its Mongolian antiquity can scarcely exceed 2000 years.

Neolithic and Mesolithic.—Last summer a great culture-camp probably of Azilian-Campignian time was found just north of the eastern extension of the Altai Mountains, within half a mile of the spot where the dinosaur eggs were first discovered in 1923. In fact, these primitive artisans used for necklace ornaments the broken shells of dinosaur eggs as well as those of *Struthiolithus,* the giant ostrich of the Stone Age of Mongolia. No human fossils have been found thus far, but the fact is established that the Stone Age tribes spread over the borders of the Gobi Desert region during the Ice Age, establishing their workshop near the large lakes bordering the Altai Mountains. These Neolithic and Mesolithic people have been named by Mr. Nelson the " Dune Dwellers," or the " Shabarakh culture," because of the occurrence in old dead and indurated sand deposits called by our geologists the " Shabarakh formation." It yields a combination of traits which appear to be distinctly Gobian.

The Neolithic stage is superimposed upon the Mesolithic, and is an outgrowth of it with certain additions and modifications. Chief among these are the occurrence of spear-heads, arrow-points, and pottery, grey or brick-red, with string-marked, incised, or geometric patterns. No spear or arrow heads or pottery occur in the definitely pre-Neolithic horizon which precedes it.

The Mesolithic stratum is characterized by hammerstones, cores or nuclei, flakes, perforators, scrapers, and disk-beads of dinosaur and *Struthiolithus* egg-shell. The chipped stone (mostly red jasper) artifacts in several specific details conform closely to the Azilian flint industry of Western Europe. We found at the Shabarakh locality literally thousands of flint artifacts and flakes both upon the surface and deeply embedded in the formation itself.

There were definite indications that this had been a favourite camping-place for many thousands of years. The geologists are certain that a lake had existed, probably intermittently, in this great basin, furnishing water for the inhabitants of its shores. Moreover, 36 miles to the west we discovered the source of supply for the flint of which the primitive artisans made their artifacts. That this culture was widespread is evident, for at nearly every place where the Shabarakh formation appeared, artifacts were present.

Upper Palæolithic.—In two localities on old erosion surfaces composed of Quaternary gravels, stone implements of Mousterian and Aurignacian types were found. Although they were not actually *in situ,* there was sufficient evidence to make us believe that they may have weathered out of the formations.

Eolithic.—This dawn stage of man's handiwork appears to be well represented in a number of places in Mongolia, especially in the region of

8. *The home of the Dune Dwellers near "Flaming Cliffs".*

Orok Nor. Here on an old erosion surface composed of Quaternary gravels lie thousands of fractured rock and pebbles, more or less weathered but showing successive stages of flaking. A number of these splintered pieces assume artificial form and character even to the extent of now and then showing the bulb of percussion. In addition, nearly all of them exhibit more or less retouched margins, a succession of chips having been removed much after the manner of true Mousterian technique. Yet the obviously varying ages of the chip beds leave no doubt that the specimens are the veritable products of natural forces still at work.

I must admit that Mr. Nelson takes very little stock in eoliths as a whole and those of Mongolia in particular. After walking for some miles behind our caravan when they were passing over a peneplane strewn with jasper rocks and large pebbles, he came to the conclusion that a camel with its feet could assist nature in making just as good eoliths as could primitive man with his hands. Rocks were broken and flaked by the weight of these heavy animals in a way which imitated most remarkably the eolithic technique. After his experiences in Mongolia, I believe I am correct in stating that Mr. Nelson would regard suspiciously the finest eolith that ever has been discovered.

I should like to make a few remarks by way of summary of the archæological work. Our chief contribution has been the discovery that primitive human beings at various periods during the Stone Age did inhabit the Gobi Desert, that they were lake-shore and river-shore dwellers, and that they wandered over an extensive area. Their cultures resemble corresponding cultures of Europe in so many respects that it appears to be probable that they were derived from a common source. Whether or not this is true it is impossible to say at present, for there is not sufficient data upon which to base positive statements.

Palæobotany.

After the 1922 and 1923 expeditions the need of a botanist was felt by all the scientific staff. The climate, rainfall, and general conditions of vegetation are most clearly indicated by the fossil plant record. What such a record would show and how it would check with the evidences furnished by palæontology and geology was of vital importance in the study of our general problem.

Dr. Ralph Chaney, a member of the staff of the Carnegie Institution of Washington, D.C., was kindly detailed to the expedition by Director J. C. Merriam. Although Dr. Chaney's interests were chiefly concerned with palæobotany, he made a collection of some five hundred living plants which are now being studied and described.

Dr. Chaney found that the fossil plant record of the Tertiary, as we had suspected, was largely confined to silicified wood because of the comparatively dry climate of Mongolia during very early times. Nevertheless,

the specimens which we obtained give a most illuminating picture of climatic conditions during the Cretaceous and Tertiary and confirm the story already told by geology and palæontology.

Dr. Chaney reports as follows :

" A comparison between the climatic conditions of Mongolia and that portion of China lying immediately to the south during the Cretaceous and Tertiary periods brings out the fact that the relative difference in rainfall which now exists between these two areas has probably extended far back into geologic times. The northern provinces of China now have a rainfall of between 20 and 25 inches annually, which falls mostly during the summer in connection with the monsoon winds. These winds do not reach Mongolia because of the intervening Khingan Mountains and other ranges which run across Northern China ; the rainfall there is only a few inches a year, and the trees are scattered or absent. On the basis of the fossil record, it may be suggested that these mountains have been in existence through the Tertiary and back into the Cretaceous period, during which time a sequoia forest whose moisture requirements were about 40 inches a year occupied their windward side ; on the north slopes, semi-arid and arid conditions not greatly unlike those of to-day appear to have existed, limiting the trees to conifers and poplars, and preventing the growth of any extensive forests.

" The living trees of Northern China and Japan are of special interest because of the similarity of the leaves of certain species to those of fossil species in the Tertiary of Western America. A species of hawthorn, *Cratægus pinnatifida*, has leaves which closely resemble those of the fossil *C. newberryi* of Eastern Oregon, and there is no living American species which shows a like relationship. One of the common elms of Northern China, *Ulmus parvifolia*, is much like a fossil elm from Eastern Oregon which has no near relative, either living or fossil, in America.

" Interesting enough, the Sequoia which is now limited to Western America is found fossil in Manchuria. We therefore have the situation of certain kinds of trees which occur in America as fossils but no longer live there, although they are present to-day in the forests of Asia ; and there are others which, though now extinct, are shown by the fossil record to have lived there in the Tertiary, and which survive in the living forests of America."

Geology.

The Geological work of the expedition carried on by Professors Charles P. Berkey and F. K. Morris has yielded most important results. In fact, they are so varied and far-reaching that it is difficult to summarize them in a few words. However, Dr. Berkey writes, as follows :

" If we were called upon to state a few of the most outstanding results achieved by the geological investigation, we would choose the following :

" 1. The geologic column, as summarized in the two tables. No such

detailed and systematic statement has been possible hitherto. Many of the formational units, several of the major erosion intervals and periods of diastrophism, as well as much of the correlation, are presented for the first time.

" 2. The recognition of the nature of the great Mongolian bathylith—one of the largest units of the kind thus far recorded. This is important, not only to " pure science," but it supports a very practical inference of far-reaching importance, namely, that valuable mineral deposits are more likely to be found about the margins of the bathylith than in the area of broad exposure. So far as the mineral resources of Mongolia, Southern Siberia, China, and Manchuria are known, this inference is supported.

" 3. The reading of the history of climatic changes. The climatic history thus far offered by the expedition is the most extensive effort of its kind yet attempted in Central Asia. The results achieved by Huntingdon in his study of the climatic changes of Pleistocene and Recent time in other parts of Asia are supported by our results.

" It is not possible to work out a sequence of events that applies to all Central Asia from the Jurassic period to the present, and that gives an especial significance to the stratigraphic column and the palæontologic history of the region. These studies of past climates have an important bearing also on the habitability of Central Asia during the period of human evolution."

The Central Asiatic Expedition to the present time has differentiated and defined fifteen formations in the so-called later sediments alone, and an equal or greater number of formations in the ancient floor, whose succession and approximate age are satisfactorily determined.

Zoology.

In this science investigations were confined to mammalogy, herpetology, and ichthyology, with the exception of small collections of birds.

The Asiatic Expeditions in China proper and Mongolia have brought to the American Museum of Natural History, 9900 mammals, 11,666 reptiles and batrachians, and 10,000 fish. These are now being actively studied and many papers already have been issued. Many new and important facts regarding the relationships and probable derivation of European and American living types are being demonstrated by these vast collections.

Future Explorations.

The three seasons' field work already completed have been confined to Outer Mongolia, north of the Altai Mountains. We feel that *for the purposes of the expedition*, this region is now sufficiently well known to warrant directing our attention elsewhere. A surveyed line more than 1000 miles long has been run north-west through the heart of the desert, thus giving accurate starting-points for any future topographic work.

We hope in the seasons of 1927, 1928, and 1929 to carry on similar investigations in Inner Mongolia. We are particularly anxious to complete another westward surveyed route south of the Altai which will connect with the excellent work done by Carruthers, Stein, and other explorers in Chinese Turkestan. To carry out such a survey will be one of the main objects of the expedition in 1927. We have reason to believe that rich sedimentary fossil-bearing basins lie in the Western Gobi, and that special attention to prehistoric archæology will be eminently worth while.

Publication of Results.

Seventy preliminary papers have been published in the *Novitates* and *Bulletin* of the American Museum of Natural History. These put on record very briefly some of the most outstanding discoveries of the expedition. Fourteen volumes of scientific results have been projected. Volume 2, on the Geology of Mongolia by Professors Berkey and Morris, is now in Press. Volume 3, also on Geology, is in course of preparation. Volume 4, on the Invertebrate Palæontology by Dr. A. W. Grabau, has nearly been completed.

The maps made by Major Roberts in 1925 have just issued from the Press.

Other final volumes on zoology and botany are in an advanced stage of preparation.

The cost of publishing the scientific results in a way commensurate with their importance is enormous. Since this expense must all be met by the funds of the expedition, the leader has had an infinitely more arduous task in providing its finances than in directing its field work.

Notes on the Photographs reproduced.

The first shows the expedition's caravan of 125 camels on its way to the " Flaming Cliffs." This is a view typical of Gobi topography, the desert floor being of decomposed rock rather than of sand. Because of this rock floor it was possible for the expedition to use motor cars. Great peneplane surfaces very nearly flat extend in some regions for many miles. The desert vegetation consists of short wiry grass, camel sage, and low thorny bushes. A very little rain will cause the entire surface of the desert to change in an almost miraculous manner: where there had appeared to be nearly dry yellow gravel, within a few hours the surface will be tinged with delicate green, showing how quickly the desert vegetation responds to water.

The second plate shows the " Flaming Cliffs," where the dinosaur eggs were discovered.

We have here an edge of a great basin eroded out of the Gobi peneplane which sweeps northward in an almost level floor from the Altai Mountains 30 miles to the south. The cliffs, which stand in grotesque forms beautifully sculptured by wind and frost and rain, are of brick-red

stone. These sedimentary basins, eroded largely by wind action, are a feature of the Gobi. In these sedimentary basins the expedition finds its fossils; in the grass lands north of the desert the strata are largely granite graywackes and other hard rock which are unfossiliferous.

The third plate gives another view of the great "bad land" basin in which the dinosaur eggs are discovered. The step-like formation is produced by wind erosion of the red sandstone. The red cliffs contrast strongly with the yellow sediment of the basin floor, which is largely coarse sand.

Tsagan Nor lies 20 miles from the base of the Altai. Between it and the mountains is a belt of sand-dunes nearly 100 miles in length, but only 2 or 3 miles in width. The dunes are composed of the finest sand, which is blown by the wind like spray from the crest of a wave. Most of the formations are of the typical barkan type, but change their shape continually with the direction of the wind. These sand-dunes are found on the southern or western shores of almost every desert lake, and even in the dune areas water is close to the surface. Quite often we were able to dig a well with our hands, having only to scoop out 4 or 5 feet of sand for water gradually to fill the depression. Clumps of long coarse grass and a beautiful bush sweet-pea growing 4 or 5 feet in height are usually found in the valleys between the shifting dunes.

The fifth plate shows the eastern Altai Mountains with the peak Boga Bogdo in the background. This peak, which rises about 12,000 feet above sea-level, had not, so far as I am aware, been climbed until it was ascended by members of the Central Asiatic Expedition in 1925. Except for a few weeks in August, the summit is usually covered with a blanket of snow. In the foreground is one of the great alluvial fans which are striking features of the eastern Altai. This particular fan was 10 miles long, and had its apex 2000 feet above the level of the plain. The fans are the *débris* washed out of the great canyons formed by the torrential rains which continually fall upon the higher peaks of the eastern Altai. Most of the fans are covered with a thin blanket of short grass, as are the slopes of the mountains themselves.

The view over the valley of Tsagan Nor, from a point below the peak of Boga Bogdo, shows in the distance, about 15 miles away, a wind-eroded escarpment, between which and the lake is an area of shifting sand-dunes. In the dry river-bed a grove of elm trees follows the line of the old watercourse.

This gives an excellent idea of the elm trees which grow in the dry river-bed. The only places in the Gobi in which we found trees were in a few river bottoms. There are no young trees among them; all show considerable age, indicating that new growth has not started for many years. In the eastern Altai Mountains themselves there were no trees of any sort: the slopes are either bare or covered with short grass.

The seventh plate is taken looking south toward the peak of Boga

Bogdo, which is nearly obscured by clouds, from the mouth of Tiger Canyon. Members of our party attempted the ascent of Boga Bogdo from the mouth of the Canyon, but found that it was impossible to reach the summit from this side. A fairly easy route, however, exists on the western slope.

The last plate shows the home of the dune dwellers. This is an area of old dead sand-dunes which have been formed around the roots of tamarisk trees. Erosion has carved valleys through the dunes, exposing great numbers of flint implements which were made by people who lived on the shores of an ancient lake. This great culture site is only a mile from the Flaming Cliffs where the dinosaur eggs were found. Indeed, we discovered bits of dinosaur egg and ostrich egg shell which had been drilled by these primitive people to make necklace ornaments.

The results of the surveys of this expedition, carried out by Major L. B. Roberts and his assistants as described in the paper, are well shown on 28 sheets of maps, copies of which have been presented to the Society by Dr. Andrews. They are as follows:

(1) Traverse, plotted on 19 sheets, of the route of the expedition from Kalgan westward for 865 miles, through Hallong Usu, Ula Usu, Shabarakh Usu, and Tsagan Nor to near Kholobolchi Nor, about 240 miles south-east of Uliassutai. This map is on the scale of 1/200,000, and shows approximate contours in brown at 50 feet vertical interval in the neighbourhood of the route. At the bottom of each sheet is a vertical section of the part of the route it contains.

(2) Vicinity of Hallong Usu, scale 1/20,000. Approximate contours at 20 feet vertical interval.

(3) Vicinity of Ula Usu, scale 1/20,000. Approximate contours at 20 feet vertical interval.

(4) Djadokata Fossil Field and Shabarakh Usu Artifact Area, scale 1/20,000. Approximate contours at 20 feet vertical interval.

(5) Vicinity of Tsagan Nor, scale 1/20,000. Approximate contours at 10 feet vertical interval. This map shows the water-line of the lake on 10 June 1925, and as it was in 1922.

(6) Five black-and-white sketch-maps of routes extending from the main route of the expedition, on scales varying from 1/400,000 to 1/825,000:

(*a*) North from Shabarakh Usu to Holostai in Suma. (*b*) West from Kholobolchi Nor. (*c*) North from Ula Usu. (*d*) South from Shabarakh Usu. (*e*) South across the Altai Mountains from Kholobolchi Nor.

These routes vary in length from about 40 to 250 miles.

The routes of the expedition are shown on the sketch-map accompanying this paper, and it will be seen that they cross parts of the Gobi desert to a great extent previously unexplored.

Before the paper the PRESIDENT (Dr. D. G. HOGARTH) said: We inaugurate our session under happy auspices—we begin it this year, as two years ago, with the Asia lecture; that is to say, a lecture founded by Mr. Dixon, a Fellow, who gave the Society a sum of money to promote lectures every two years upon the continent of Asia. The first of these was delivered by that great authority

so well known to us all, Sir Aurel Stein, and many here will recall the massive and masterly exposition of mediæval Asiatic history which he then gave. To-night we are going to another part of Asia, and we call upon an authority no less distinguished than Sir Aurel Stein to tell us about it. Dr. Roy Chapman Andrews, who is Curator in Chief of the Department of Asiatic Exploration in the great Museum of Natural History of New York, has spent, I believe, five seasons in Mongolia. He comes here with the widest of reputations, for what he found in Mongolia has become known to the whole civilized world. The discovery of the dinosaur eggs alone would have sufficed to make him notorious and remembered. But he is going to tell us to-night about a great deal more than dinosaur eggs: about the organization of almost a new form of exploration—the realization of what I ventured in my presidential address a few months ago to hope would be the work in the future of this Society—that is, intensive study of a particular area. With that extraordinary thoroughness, and I must also say with those great means which are at the disposal of Americans, he was able to concentrate upon one great but defined area the resources of almost every kind of science; and although it is practically impossible for Dr. Andrews in the short time at his disposal this evening to put before you anything but the merest outlines of the results of so large and well run an expedition, he will at any rate try to give you some idea of the organization that such exploration entails. This is, therefore, a very notable moment in the history of the Society; it is about to hear what the exploration of the future is to be. The great journeys of exploration are probably done in almost all the world; the great pioneer lines have been thrown across the continents. What we have to do now is to fill up great gaps between those single lines. Dr. Roy Chapman Andrews is going to show you how this has been done in a most interesting region, Mongolia. I call upon him to give you such account as he is able to do in the time available of this fertile and now famous exploration.

Dr. Andrews then read the paper printed above, and a discussion followed.

Sir FRANCIS YOUNGHUSBAND: I am all with the President and with the lecturer as to the necessity of intensive exploration of comparatively small areas, but I hope you will realize that it is somewhat embarrassing to the unfortunate traveller who may many years ago have made a trail across one of those small areas when an army of experts comes along with a well-organized expedition, and descends upon a little point in that trail and focusses attention upon it. A day or two ago I had the great pleasure of meeting Dr. Andrews, and before a quarter of an hour had passed he showed me on the map where he had struck my trail of 1887, and asked me if in the course of that journey across the Gobi I had seen any likely places for dinosaur eggs! I ran my mental eye along the 1200 miles of the Gobi that I had passed through and asked myself, "Now, can I honestly say that at that particular place you could be dead certain to find dinosaur eggs in hundreds?" I could not do it. But I have this afternoon handed over to Dr. Andrews the actual diary which I kept at the time, though I hope that, as I was then only twenty-three years old, he will be lenient with my very poor observations. In spite of the embarrassing questions previous travellers are asked, it is delightful to hear a lecture such as that delivered by Dr. Andrews this evening, and to see the beautiful photographs of the Gobi. That is an enormous satisfaction to me because I had no camera with me, and until this day I have never seen any picture of the country I passed through. We are too accustomed in this Society to have placed on the screen dreadful dull grey photographs, but Dr. Andrews has brought us

coloured pictures which have given us a most delightful impression of the desert. And a desert is not the barren kind of affair we are inclined to think it; it has plenty of colour about it. Dr. Andrews has spoken of the sunsets in particular, and he claims that they are the finest seen anywhere in the world. I should like to corroborate that, for I have a vivid recollection of the sunsets in the Gobi. I used to start on my day's journey at five o'clock in the evening and go straight at the sunset, travelling until one or two o'clock in the morning. An indelible impression has been left upon me of the magnificence of these desert sunsets.

I should like to add that an expedition such as that described cannot be carried out unless the leader has great organizing capacity. He has, first of all, to spend a year or two in organizing the whole expedition. That in itself is an enormous undertaking: getting the men and money together, as well as the whole of the supplies. And then one can realize what it must have been in the field to coordinate motor cars and camels. When I crossed the desert motor cars had not been thought of. To get Americans, British, Mongols, Chinese, and Heaven knows who else to work together requires in the leader magnificent capacity for organization. And what the lecturer said is perfectly true. Every leader feels that he cannot carry out what he has to do without the men working under him—that he is indebted to them for a great part of the success of the expedition. But success is not due to them entirely. In the main, the success of the expedition must depend upon the leader himself. We can gather from what the lecturer has said and from the way in which he spoke of his men that he is an ideal leader of an expedition. And we in this Society ought thoroughly to realize that.

In conclusion, I should like to say that we must admire also the pluck which Dr. Andrews has shown this evening. He underwent an operation upon his eye only last Friday; he was in bed until a couple of hours ago, but he came here to give us this lecture, and he has given it in a thoroughly manly, delightful, and humorous way. It has been a pleasure to listen to him, and we congratulate him most sincerely upon the success of the expedition, and wish him even further success on the final part which he will carry out next year.

Prof. D. M. S. WATSON (Professor of Zoology, University College): As a palæontologist it gives me the greatest pleasure to have the opportunity of speaking after the address Dr. Andrews has given. The expedition he has designed and conducted is without parallel in the history of palæontological science. In the course of three or four years he has brought our knowledge of the history of life in Mongolia from literally and absolutely nothing, except one rhinoceros tooth, to a stage which in the United States of America, which is parallel in size and complexity, was reached only after thirty or forty years of investigation, not by a single authority but by many museums and by the Survey. I do not think anywhere there is any other piece of geological work carried out on the scale of a whole continent, as it were, which has given us at once the history of a large area throughout the whole of Jurassic, Cretaceous, and Tertiary times. Not only have we now this geological knowledge, but we have also revealed to us new and most important types of animals, particularly those little mammals recently described by Drs. Gregory and Simpson, which came from the same beds as the dinosaur eggs, which will, I am sure, prove to be of the utmost importance.

Apart from such finds of interesting creatures, we have the fact that there has been verification of many—not of all—of the conclusions which President Osborn drew from his studies of the distribution of mammals of the world.

We have verification of the idea that Mongolia was one of the great centres, if not the greatest of all centres, of the evolution of mammals, and that gives great satisfaction to those actually working on palæontological material. To have one's convictions verified is the test of the value of one's type of scientific work. For that we have to thank Dr. Andrews. We have also to thank him for providing us with a perfect model of the way in which such palæontological expeditions should be worked. We have had investigations carried out in the field by those men who will work out the results in the laboratory, and this for all the sciences which are capable of throwing light on the problems to whose solution the expedition has been directed.

Dr. F. W. THOMAS (Librarian, India Office): The Royal Asiatic Society doubtless has a profound interest in the subjects dealt with in Dr. Andrews' lecture, but probably with its present limitations that interest will become keener in proportion as the subject-matter approaches prehistoric times. On behalf of that Society I may, however, say that Dr. Andrews' lecture has fully fulfilled the keen anticipations with which it was awaited. He has shown himself a master, not only of the organization of expeditions, but also of the exposition of the results of an expedition.

We have not heard much from Dr. Andrews concerning the present Mongolians, but there is a Mongolian history in which a full description of them is given, and I have also read that there is a certain Mongolian superstition which stands in the way of research in that country. It is thought that certain operations may result in carrying away the luck of the country. I am afraid Dr. Andrews' expedition has deprived Mongolia of a good portion of its luck. And I should like to point out that there are in Mongolia many persons who could have told Dr. Andrews the whole story from beginning to end, namely, the reincarnate Lamas who are said to have lived through all the stages recorded in the results of the expedition! If Dr. Andrews had sought the permission of the Lama of Urga to remove the bones of one of the dinosaurs the Grand Lama might have replied that it was a long time since he used those bones!

Sir SIDNEY F. HARMER (Director, Natural History Museum): There is only one possible reason why I could have been asked to address any words to you this evening. Dr. Andrews represents one of the great centres of science in the United States; he comes from the American Museum of Natural History, and I, on my part, have the honour of representing an institution of a similar character on this side of the Atlantic. It is perhaps fitting that I should be asked to say two or three words just to explain the admiration that his colleagues on this side of the Atlantic feel for the great work Dr. Andrews has been carrying out in Mongolia. The British Museum and the American Museum of Natural History have a great deal in common. I am not going to indulge in the unprofitable task of comparing their relative importance. I would rather say that we are thoroughly united in our main objects, one of which is the search for scientific truth. Dr. Andrews has already explained that in going to Mongolia he was actuated by the desire to find out what is true and not to prove any theory. That is the real spirit which actuates science in general, at any rate any which is worthy of the name. We have followed with the greatest admiration the work that Dr. Andrews has done. You will agree, from what he has told you, that he has thoroughly deserved success. I think the account he has given of the practical way in which the expedition was carried out is extraordinarily instructive. We have very much to learn on this side of the Atlantic from what our American brothers have been doing.

I have therefore merely to say that I should like on behalf of all representatives, as far as I am entitled to speak for them, of geological and allied sciences in this country, to express our cordial congratulations to Dr. Andrews for the great work that he has done and to emphasize the fact that the work really is great. The American expedition has discovered an enormous amount which we did not know before; an enormous amount of the sort of information we are especially anxious to have. I have only one little piece of regret with regard to the expedition—that it has taken Dr. Andrews away from the study of whales, a group in which I am myself specially interested, and on which he seemed to be rapidly becoming the principal authority when I first had the pleasure of making his acquaintance some fourteen or fifteen years ago. If any of you wish to find an instructive and extremely interesting account of whales, I should recommend you to consult a little book Dr. Andrews published some years ago called 'Whale Hunting with Gun and Camera.' In the whaling expert you will hardly recognize the explorer of Central Asia, except that he shows now the same qualities of ability, perseverance, and success of which he gave evidence before. I have great pleasure in congratulating Dr. Andrews on the splendid results he has achieved.

The PRESIDENT: The speeches to which you have listened since Dr. Andrews' lecture have been one succession of votes of thanks, and it is not necessary for me to move anything more formal. Dr. Andrews may rest assured that we are most grateful to him, and appreciate enormously his courtesy in coming specially from New York in order to speak to us to-night; that we are particularly appreciative of the fact, which Sir Francis Younghusband revealed, that Dr. Andrews has been none too well since he landed in this country; and that he has pulled himself out of bed in order to keep with you the engagement which he has so magnificently fulfilled. Incidentally, he has proved the peculiar virulence of the London climate; for I believe Dr. Andrews spent five seasons in Mongolia without suffering from any such infliction as fell upon him after three days in London. We must all wish him every conceivable success in the years to come. He was unable to go to Mongolia this last year owing to the Chinese Civil War. We must hope that next season, at any rate, the Chinese Civil War will shift to some other part of China, and not interfere with the prosecution of his great expedition.

I do not know that I have ever listened to any lecture which gave me such a sense of reserve of information and reserve of power. There was an enormous amount more that we should like to have heard and which I, for one, would gladly have listened to for many more hours. I should like, for example, to have heard more about the forest region of Mongolia which Dr. Andrews mentioned at the beginning of his lecture. He did not actually take us to Urga or show us anything to illustrate it. No doubt when he comes again, as we hope he will, he may talk to us about a different part of Mongolia, and show us different landscapes. They can not be more attractive or interesting than those he has shown; but they will be different. I am sure you will express with the utmost cordiality your sense of what Dr. Andrews has done for you this evening.

THE EAST ANGLIAN COAST

J. A. Steers

Read at the Afternoon Meeting of the Society, 15 November 1926.

1. Introduction.

THIS paper deals with the coastline from Hunstanton to the Orwell-Stour estuary (*i.e.* the East Anglian shore *sensu stricto*). Along this stretch great changes have taken place in historic times and many excellent examples of shore phenomena occur. The detailed study of many parts yet remains to be completed. Observations are still being made on Scolt Head Island and Blakeney Point which, it is hoped, will yield valuable information for future work. Meantime some interesting features on both the Norfolk and the Suffolk coasts, which the writer has studied in some detail during the past four years, may afford a sufficient basis for a general paper. The whole of the East Anglian shoreline is a well-known example of a submerged low coast. This submergence took place in all probability in Neolithic times. At the completion of the process the coast must have been extremely irregular, especially in Suffolk and Essex. Evidence for this submergence is found in the numerous drowned valleys and occasional submerged forests, as that at Brancaster. In the course of time marine erosion cut back the promontories, and longshore currents, passing along the coast, carried the material worn away from the promontories and deposited it across the estuaries. In this way rivers were either deflected by a shingle and sand spit or else completely dammed. Concurrent with this marine deposition the very fine particles carried by the streams were deposited on the inner side of the spits and bars. The origin of the Norfolk Broads is of this nature.*

To-day casual inspection of any map of East Anglia shows that the coast of the southern part of Suffolk and Essex is much more indented than that of Norfolk and Northern Suffolk. This may be explained either by one or other of the two following causes, or by a combination of both.

1. The submergence may have been in the nature of a tilt, so that Essex was depressed more than Norfolk and Suffolk.

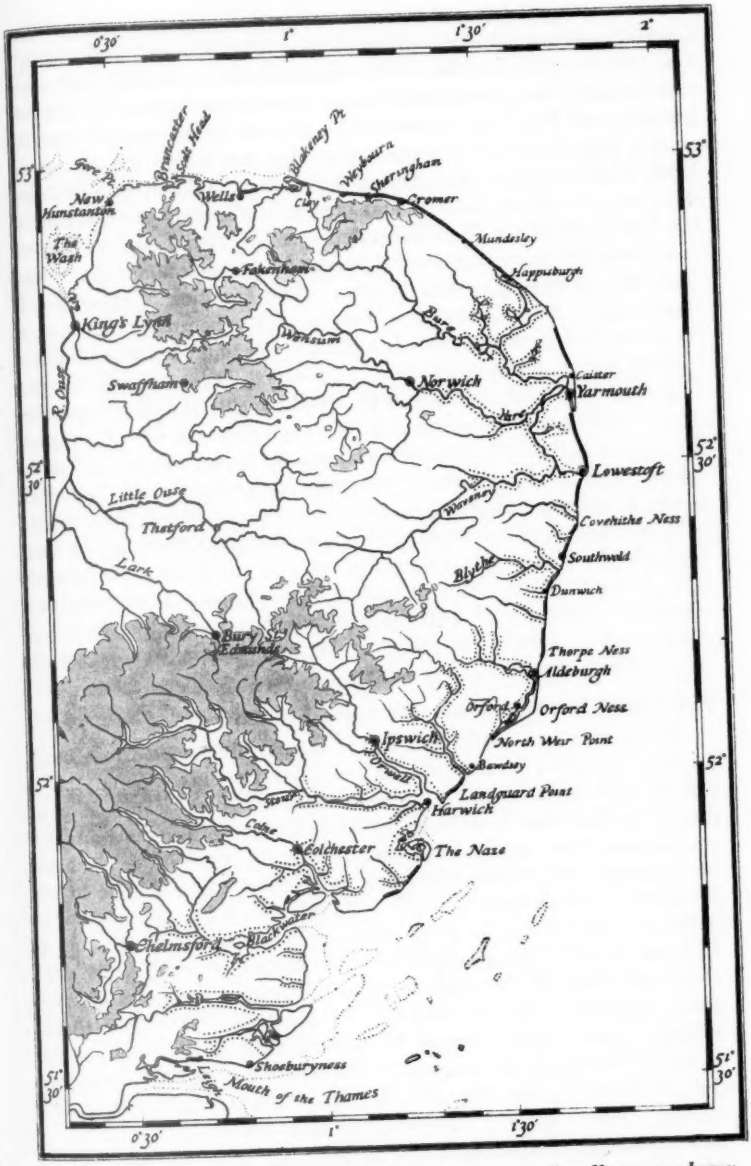
2. The shingle and sand along this coast, at any rate east and south of Sheringham, travel to the south. It follows that the more northern irregularities would be the first to be smoothed out.

Certainly there is much less shingle along the coast south of Landguard Point, at the mouth of the Orwell, than north of it.

It is with these spits and bars that this paper is more particularly concerned.

Geologically the area is one of soft, non-resistant strata. At Hun-

* Gregory, *Nat. Sci.*, vol. 1, 1892, pp. 347–355.



1. *Sketch-map of EAST ANGLIA. The drowned valleys are shown diagrammatically by dotted lines, and cliffs by heavy lines*

stanton, facing the Wash, the cliffs are formed mainly of chalk. The gradual eastward dip of the chalk brings it below sea-level near Sheringham, where it is succeeded by Tertiary deposits. Covering both chalk and Tertiaries are glacial beds—sands, gravels, eskers, etc. It is highly probable that these beds are the source of much of the shingle along the coast. The chalk can be traced as a ridge just within the flat marshlands all the way from Hunstanton to Blakeney, and even to Weybourn. This ridge is an old sea-cliff and presumably formed the shoreline at the conclusion of the Neolithic submergence. Hence, on the Norfolk coast there has been time since that period for the accumulation of vast sand flats, shingle spits, and marshes. The evolution of these spits is traced later. Marshland ceases abruptly at Weybourn. From here, as far as the Thurne River, there is a more or less unbroken line of cliffs of varying height and of fairly uniform softness. These cliffs are suffering very marked erosion, as testified by measurements at Cromer and elsewhere. Between Sheringham and Weybourn there are one or two gaps, dry valleys, in the cliffs, which are comparable to the " Valleuses " of the Chalk Cliffs of Normandy.* Between Happisburgh and Yarmouth is the Broadland proper. Flat fenland areas, separated from the sea only by shingle bars, perhaps capped by sand-dunes, alternate with short lines of cliff. These cliffs cease at Caister, and give place to the formerly wide estuary of the Bure–Waveney river system. From Gorleston southwards lines of cliff and estuaries, wholly or partially blocked by shingle spits, alternate in fairly regular sequence, in some cases the spits attaining great size, as at Orford.

2. Travel of Beach Material: The North Norfolk Coast.

Along the east coast of England it is generally accepted that beach material is moved southwards by longshore currents. While this is true of much of the coast, it by no means holds good for all. A great deal of detailed work is still necessary before one can formulate any precise notions of the local currents and their effects between the Wash and Sheringham. At Sheringham † the breakwaters cause shingle to pile up on their western sides, pointing to an eastward drift. But there is an unbroken line of shingle from Sheringham westward to the end of Blakeney Point. This headland has quite definitely grown to the west, and is still doing so. It appears, then, that there is a reversal of movement somewhere near Weybourn. In his book, 'The Sea Coast,' Wheeler gives a map showing his general view of the tidal currents along the east coast of England. The southward-moving water from the Lincolnshire coast bifurcates near Sheringham, and a sort of eddy current is shown running westward from near that place.

* De Martonne, " Traité de Géographie Physique," 4th ed., pp. 976 *et seq.*, and Plate XVIII.

† 'Royal Commission on Coast Erosion,' vol. I, Pt. I., 1907. First Report. Minutes of Evidence, 2517–2520 (C. Reid), 2672 (C. Reid), 4148 (W. H. Wheeler).

Whilst it is probable that such an eddy does exist, it does not seem to be just in the position Wheeler gives it. From his map it looks as if Blakeney Point has been formed largely under its influence. This is not so. If a table (see below) is made showing the times of high water at various parts on the Norfolk coast, it shows that high water is later both east and west from a place near Wells Bar. This suggests that the bifurcation (if it exists) shown by Wheeler's map takes place near Wells, the water moving east and west from there.

	H. W F. and C.*
Hunstanton	6·25
Thornham	6·23
Brancaster	6·22
Burnham	6·21
Wells Bar	6·20
Stiffkey	6·29
Blakeney Bar	6·30
Cromer	*c.* 7·0

In order to make sure if such an eddy as Wheeler shows had any influence on Blakeney Point a considerable number of observations, some extending over a period of about twelve hours, were made off the Hood (see Fig. 2) at Blakeney. Similar observations were also made at Scolt Head. The method usually adopted was to note the drift of floats. Bottles which were almost completely submerged were used, because the effect of winds on them was comparatively small and had no appreciable influence on the direction in which the bottle drifted. In order to obtain a rough idea of the speed at which the bottle moved, each observation was timed over a length of 100 to 200 feet. As the tide rose or fell sandbanks were gradually submerged or uncovered, and at times it was impossible to make an observation because the float could not be thrown clear of the waves breaking on the banks. However, after making allowance for this, the results obtained were tolerably uniform and showed very clearly the direction of drift.†

The evidence derived from these observations, and from several others based on similar data obtained in 1925 and 1926, is strengthened by a statement made in writing to the author by the officer in charge of the now disbanded Coast Guard Station at Morston: "The tide moves off the Hood and Marams close inshore, *easterly* up to two hours after high water with an inset to south-east, and two to two and a half hours after top of flood up to three hours on flood (the tide runs in a) *westerly* (direction)." These facts seem to prove quite definitely that no such current as Wheeler's map shows exists actually alongshore at Blakeney.

* See Admiralty Chart 108 (1924). Further information was obtained from H.M. Coastguard, Brancaster Staithe.

† At Scolt other observations were made with anchored glass floats. These gave similar results, but were not quite so satisfactory.

There is another factor of considerable importance in the effect of tides which is sometimes overlooked. The direction of tidal drift is well known to change with ebb and flow, but at the same time there is a difference, often considerable, in the level of the water, so that material worked on at high water is quite distinct from that worked on at low water. In other words, there may be two distinct and opposed movements of beach material on the same foreshore. To some extent this appears to be the case between Hunstanton and Sheringham, but how far it is so it is at present impossible to say, on account of the many irregular channels along the coast. But what is particularly noticeable is that in several cases the entrance to a harbour shows a double deflection. In the case of Blakeney, for example, the shingle, which lies above and quite distinct from the sand, has pushed westward and caused a deflection of the harbour mouth in that direction. Since the shingle is usually high on the beach, it follows that it is only worked on at high water. On the other hand, the sand at the lower level has deflected the mouth eastwards.* The shingle is the more important factor, but the effect of the sand cannot be ignored, although it is more than probable that the wanderings of the channel in the sand are related to changes in wind direction, the effects of storms, and other factors which can hardly be reduced to a constant law. Similar cases occur all along this part of the coast: in each of them the shingle shows a westward movement, the sand sometimes westward, sometimes eastward.†

If, then, the shingle spits have grown in a direction not always in conformity with the tidal currents, some other explanation than that generally accepted is demanded. Before a final decision can be made, a much greater number of observations are necessary.‡ But two factors appear to bear directly on the matter. Along the whole of the East Anglian coast the prevalent winds are south-west or south-south-west. These are not the dominant winds. The dominant winds come from the quarter between north and east, and blow over the greatest fetch of open water; hence they can generate larger waves, which cause material to move westward by beach-drifting.

When these latter winds blow, following a period of north-west and north-north-west winds, and when they coincide with a spring tide, the greatest amount of damage is done on the East Coast. The level of the water is then higher than usual, and in a north-east storm the shingle banks, dunes, and soft cliffs offer but little resistance. In this way much material is prepared for redistribution, and is partly redistributed. The second point is the possible effect of the prevalent south-west and south-south-west winds. These are in number much in excess of winds from

* It should be noted that the harbour entrance is very variable.

† I am indebted to Dr. Vaughan Cornish for certain suggestions in this connection.

‡ Mr. Chestney is now making long-period observations at Scolt Head, which, is is hoped, will help to solve this problem.

any other quarter, and together with calms make up more than half the total winds for the year. They blow off shore and oblique to the shore. The tendency of an off-shore wind is to cause a bottom current toward the shore in the contrary direction to the wind itself. Assuming this to be the case, the under-current should come from the north-east or north-north-east. These winds are "normal" winds for the most part, and not necessarily connected with storms. They may perhaps be responsible for a certain amount of westward drifting.* The beaches are "combed down" when winds are from a northerly quarter, and "make" when the winds are from a southerly quarter. Storms from the north or north-east cut away the beach, and the material thus dragged down is later built up in normal times. Whether the undertow due to the north or north-east winds carries material directly out to sea is debatable. Theoretically it should do so, but in the case under discussion the water as a whole is very shallow, and under the impulse of a strong wind and a storm from the north-north-east or north-east it is not improbable that the whole body of water in the immediate proximity of the breakers would have a westward motion.

A point which is of some interest here is that it is noticed frequently that in calm and moderate weather with winds from any direction, the waves approach from the quarter between north and east. A particular case may be instructive. On 19 September 1926, a particularly fine day with a very calm sea, the wind all day blew from the land, freshening at times to a moderate breeze. Throughout this period quite small waves were coming in from the north-north-east, and the writer noticed shingle being moved westward by the breaking waves whilst the tidal current was running eastwards—and a little outwards within 50 yards of the shore. Such waves may be the product of wind conditions far out in the North Sea: the waves travel on long after the impulse has ceased, and cause the westward beach-drifting.

3. Blakeney Point and Scolt Head Island.

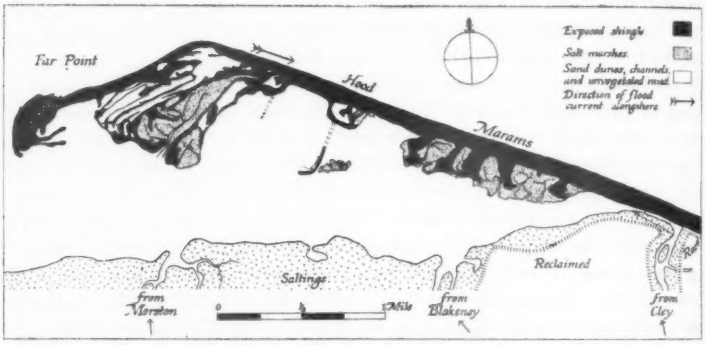
Reference has already been made to Scolt Head and to Blakeney Point. They are the two principal shingle and dune headlands of this part of the coast. Blakeney Spit begins at Weybourn and runs westward for about 8 or 9 miles. At its westward end it has many backward bending ridges, most of which are covered with sand-dunes. New additions are constantly being made to the Far Point. These new beaches have been called apposition beaches (*vide* Description of Blakeney Point in chap. xii., 'Tidal Lands,' Carey and Oliver, 1918).† The main

* See also below.

† See also several papers in the *Journal of the Norfolk and Norwich Naturalists' Society*, and the following Blakeney Point publications: No. 4, 'Blakeney Point, Norfolk. The New Nature Reserve,' F. W. Oliver; No. 7, 'Topography and Vegetation of Blakeney Point, Norfolk,' F. W. Oliver and E. J. Salisbury; No. 11, 'The Structure and Water Content of Shingle Beaches,' T. G. Hill and J. H. Hanley;

beach is now being rolled steadily landward: the motion is virtually that of a moving sand-dune, though much slower. Along its inner side are frequent recurved ridges. These occur in clumps, as at the Marams and Hood. It is more than probable that the ridges at the Marams and Hood are merely of greater magnitude than those which formed constantly as the spit grew. These smaller ridges have been quite obliterated by the landward travel of the whole spit. The dunes are a secondary feature, being formed on the shingle ridges.

Scolt Head is now an island. The eastern entrance to the channel in rear is Burnham Harbour. There is not much doubt that this is really a break-through, due to the ponding back of the water in the channel at a high tide, which caused it to push through at a weak point in the spit.* Such a ponding back of the water could take place quite easily as the result of powerful north-west or west-north-west winds acting with a high spring tide. Similar phenomena are known at Orford (*q.v.*).



2. *Development of Blakeney Point, after F. W. Oliver, 'Trans. Norf. and Norwich Nat. Soc.,' vol. xi. pt. v.*, 1923–24

The general trend of the island is continued directly in a dune-covered shingle ridge east of Burnham Harbour and within the present main dune ridge there. This latter ridge has grown a good deal in comparatively recent times. Viewed from the north-west extremity of Gun Hill Ridge (a high dune near the harbour mouth) the impression that both island

Blakeney Point Reports, 1913, 1914, 1915–1916, 1917–1919, 1920–1923, in vols. of same years in *Norf. and Norwich Nat. Soc.*; F. W. Oliver, "Scolt Head and Blakeney Point," *Norf. and Norwich Nat. Soc.*, 11—Pt. 5, 1923–1924.

* For further evidence on this point see F. W. Oliver, "Scolt Head and Blakeney Point," *Norf. and Norwich Nat. Soc.*, 1923–24, pp. 573–4. At the eastern end of Scolt Head Island is an *Aster* marsh, which, in the time sequence, is out of place, but which may be accounted for as an older marsh which was rejuvenated when the break-through occurred.

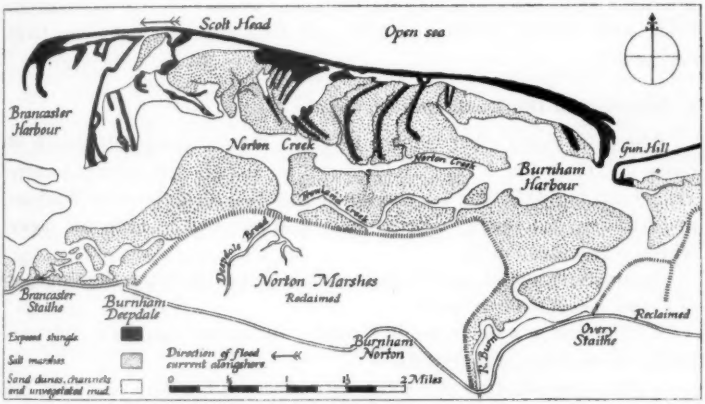
See also F. C. Deighton and A. R. Clapham, "The Vegetation of Scolt Head Island: A Preliminary Account," *Norf. and Norwich Nat. Soc.*, vol. **21**, pt. i., 1924–25, pp. 86–111.

and dune ridge east of the harbour once formed one and the same feature is greatly strengthened.

The writer is at present engaged on some detailed work on Scolt Head Island, but one or two general points may be of interest here.

This island, like Blakeney Point, has been growing westwards rapidly in recent years. Some measurements made in 1925 showed that between the years 1886 and 1904 the average annual growth was about 283 feet. Between 1904 and 1925 the annual progression apparently dropped to an average amount of 150 feet. These measurements were made from the 6-inch maps of 1886 (published 1891), 1904 (published 1907), and a plane-table survey made by a party of botanists in 1925.* With this very rapid westward growth there has been a corresponding landward movement of the main beach.

Throughout the length of the island there are numerous examples



3. *Structure of Scolt Head Island in* 1907, *adapted from F. W. Oliver, loc. cit.*

of long recurved ridges. These do not show any particular grouping, except that they are rather more numerous along the western half of the island. A marked characteristic of these recurved ridges—and those of Blakeney as well—is their great length. Frequently they themselves show secondary recurving, sometimes in very complex fashion. Both Scolt and Blakeney have grown westwards by successive additions of these recurved ridges at their western extremities. In both cases many of the ridges are now dune covered.

In one important respect Scolt differs from Blakeney. At this latter

* Steers, "Scolt Head," *Norf. and Norwich Nat. Soc.*, vol. **12**, 1924–25, pp. 84–86; and also vol. **12**, 1926–27. Further mapping was carried out by O. D. Kendall in 1926; his results confirm the figures given above (*Norf. and Norwich Nat. Soc.*, vol. **12**, 1926–27).

place it has been shown that the flood current close inshore is running in opposition to the growth of the main beach. This is not the case at Scolt. Similar observations were made here, and the movement of the tidal currents close inshore may be summarized thus: With a rising tide the water is moving westwards and the turn takes place about the time of high water.*

At Scolt, then, the flood current is running with the shingle, and may possibly aid in its transportation. However, the action of waves is almost certainly the main factor. Assuming this to be the case, both Scolt and Blakeney owe their origin to beach drifting by wave action. The swash of a wave when breaking drives up material of all sizes in the direction of approach: when the wave retreats some of this material is left stranded; the remainder returns directly seawards under the force of gravity. Thus the various particles and pebbles describe parabolic paths, and gradually shift westwards with the dominant waves. A few experiments made with marked pebbles at Scolt and Blakeney bore out these facts very well.†

4. Summary of the North Norfolk Coast.

There are many other features of great interest along this stretch of coast, *e.g.* Gore Point, near Holme, another shingle spit subject to very violent and rapid changes ‡; and the unprotected marshlands at Warham and Stiffkey, but further details must be suppressed to keep the paper within reasonable limits.

In summarizing the recent history of this part of the coast, the sequence of events seems to have been:

1. The land was depressed in Neolithic times, and the chalk cliff, now inside the marshes, was formed.

2. The general drift down the east coast of England has been responsible for the vast accumulations of sand which underlie the marshes and extend many miles out to sea.

3. The sorting action of the waves has, to a considerable extent,

* One other small point may be noted. Along the main beaches at Blakeney and Scolt there are often to be seen many shallow channels between low sandbanks and the beach. These sometimes upset the normal run of the water when they are only partly filled. Their presence can hardly have any real effect on the beach, inasmuch as they are very local and transitory.

† Although evidence points to the waves being the dominating factor in beach drifting at both Scolt and Blakeney, the tidal currents may have a secondary effect. This is probably the case at flood and ebb, when heavy waves churn up the sand and shingle off shore. Some of the material so disturbed must be acted upon by the tidal currents and carried along in intermittent suspension. It is almost impossible to demonstrate this action, and it is only likely to take place outside the line of breakers. Shoreward of that line material can be acted upon only by the waves. As the offshore zone along all this stretch of coast is very shallow, wave effects must be felt down to the bottom well off shore.

‡ A. S. Marsh, *Journal of Ecology*, vol. **3**, 1915, pp. 65–93.

separated the shingle from the sand, and the shingle is now built up into long spits and bars.*

4. With the growth of these spits and bars, salt marshes gradually began to form on their landward side, and later land has been reclaimed by man.

5. The accumulation of the sand and the effect of the bars in breaking up the evenness of the coast have caused a growing complexity in the tidal currents, and these again are much influenced by the Wash.

6. After the formation of the shingle bars, sand-dunes were formed on them by wind action over the great sand flats which are exposed and partly dried at low tide.

7. Vegetation has helped in the fixation of shingle and dunes, and many of these forms are now stable.

8. Although accretion is in excess of erosion along most of this coast, the shingle bars are all gradually being rolled landward over the marshes by wave action.

Clement Reid † suggested that this stretch of coast marks a former river-bed, a river which flowed eastwards from the Wash to the Rhine. There are certain gravels within the marshes, as at Cley, which may perhaps point to river action, but very little is known of them. The fact that marsh mud is found outside the main beach at Weybourn seems to the writer to be evidence more in favour of the landward rolling of the beach as a whole than of a former river channel. Further, the chalk cliff does not resemble anything so much as a former sea-cliff, from which the sea has retired by means of constructing shingle bars on the shallow off-shore bottom by its own action.

5. Sheringham to Lowestoft: Lowestoft Ness.

Eastwards from Sheringham there appears to be nothing abnormal in the travel of beach material: shingle and sand are in constant transit to east and south. Occasionally, in big storms, the beach may, in places, be quite denuded of shingle and the underlying clay (marsh mud for the most part) exposed. However, in normal times the beach is once again replenished. Along all this part (Sheringham to Caister) erosion is predominant, and past records show how greatly the sea has encroached on the land. Apart from the damming back of small streams, such as the Thurne, and the formation of broads,‡ there is nothing of any great interest on this part of the coast in so far as the present paper is concerned.

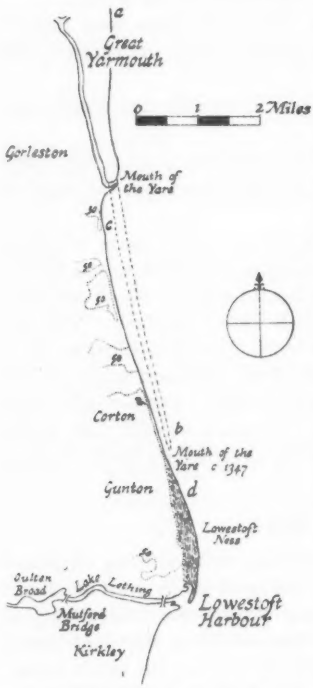
Of Yarmouth a brief *résumé* of coastal changes during historic times is necessary in order to introduce a suggestion for the formation of

* It is a point of some interest whether some of these shingle bars are of the nature of true offshore bars rather than spits formed wholly by longitudinal accretion.

† *Vide* 'Mins. of Evidence of Royal Commission on Afforestation and Coast Erosion, 1907,' Appendix xii. pp. 163–172.

‡ The question of the formation of the Norfolk Broads has been discussed by other writers, and therefore is not considered here.

Lowestoft Ness.* Traditionally, Yarmouth is said to have originated as a small fishing encampment on a sandbank which formed across the wide estuary of the Yare–Waveney about the year 1000. The "Hutch Map" (A.D. 1000 ?) is a picturesque attempt to show the coast as it then was.† While no reliance can be placed on such a map as this, there is no reason to doubt that such a bank would form across the estuary, and would in course of time become joined to the mainland. At first there were two entrances to the river, one to the north of this bar, called Grub's or Cockle Haven, and one to the south. The northern one was soon obstructed by shingle and sand travelling from the north, and consequently the southern entrance developed into the main one. But this, too, was subject to great fluctuations, and was gradually pushed farther and farther southwards, attaining a maximum distance from the present town of Yarmouth about 1347, when it reached to a point somewhere between Gunton and Corton. Naturally such a shingle spit was a considerable hindrance to navigation, and the burghers of Yarmouth had to make many cuts through it. The present entrance to Yarmouth Haven (apart from minor shiftings) dates from 1566.‡



4. *Sketch-map of the Yare spit*

The growth of this Yare Spit seems to have had a considerable influence on Lowestoft. At the latter place the cliffs are now fronted by a flat shingle and sand foreland, called the Denes or Ness. Gillingwater, § the historian of Lowestoft, says that in Roman times these cliffs were reached by the sea. Unfortunately, no definite evidence is given for this statement. It is, however, by no means improbable for reasons which will appear

* *Vide* Redman, "The East Coast between the Thames and the Wash Estuaries," *Proc. Inst. Civ. Engs.*, vol. 23, p. 186; and *Geol. Sur. Mem.*, 1890, "Yarmouth and Lowestoft," Blake.

† A much more accurate picture of the coast in early times can be obtained from a study of the 1-inch geological map, the alluvial areas on this map corresponding approximately with former arms of the sea.

‡ Vide *Mem. Geol. Sur.*, J. H. Blake, 1890. This is the eighth haven.

§ E. Gillingwater, 'An Historical Account of the Ancient Town of Lowestoft, in the County of Suffolk.' 4to. London: 1790.

later One piece of evidence does certainly point to the comparatively late growth of the Ness. The first known mention of it appears in the Hundred Rolls, temp. Ed. II.* The map shows that at the present time the general trend of the line of cliffs from Gorleston to Corton is continued along the outer line of the Ness (*c* . . . *d* on map); and that near Corton the cliffs themselves take a fairly conspicuous change in direction.† If, in imagination, the former Yare spit be prolonged as it was in 1347, it will be seen that its outer edge was continued more or less into the line of cliffs now standing at the back of the Ness at Lowestoft (line *a* . . . *b* on map). In 1392 a second haven was cut at the north end of Gorleston. Four other cuts were made before 1566 when Yarmouth harbour was stabilized, and shingle travelling from the north was held up there by groynes. As a result of these several cuts the shingle of the severed part of this spit became "dead," and sooner or later disappeared southwards. This having taken place, the sea could cut into the cliffs between Gorleston and Corton, there being very little shingle travelling down the coast to protect them. Such erosion would probably become pronounced near Gorleston, because there the amount of beach material would be least (*i.e.* just under the lee of Yarmouth Harbour).

Possibly the sea attacked the cliffs at Lowestoft also. But, arguing from a similar case at Shingle Street (see Orford map), there is reason to expect that a certain amount of shingle had collected here. This would be natural enough since the Yare spit was comparatively thin, and large masses would be cut off in storms and probably driven ashore at or near the present position of North Lowestoft. This shingle would naturally protect the cliff in rear and so help to withstand the attack of the waves. Working on this assumption, then, we may conceive of the sea gradually forming the broad bay between Yarmouth and Corton, and the longshore current,‡ moving southwards, carrying a certain amount of material from this stretch of coast. In other words, the longshore drift gradually changed from the line *a* . . . *b* to the line *c* . . . *d*. When this current reached Corton the shingle at the foot of the cliffs diverted its course a little seaward, leading to further deposition and eventually to the formation of a spit or ness. Together with this action there was probably (as already noted at Blakeney and Scolt) a general landward movement of ness and cliffs alike. This is still going on, and Lowestoft is making expensive provisions, in the form of sea-walls, to resist this erosion. It is highly doubtful if they will be of any permanent value. The natural protection of any coast is a beach of the sea's own construction. As long as Yarmouth cuts off the beach supply from the north, so long will Lowestoft suffer. It is interesting in this connection to note that the

* Redstone, V. B. Information contained in a letter to the writer.

† This is more apparent when viewed actually from Lowestoft Denes.

‡ This term is used in a broad sense here and includes beach drifting.

holding up of beach drift at Yarmouth is causing the beach there to prograde and the dunes to the north of the town to extend.

The question of time involved in this suggestion for the formation of Lowestoft Ness is important. Exactly how far the Yare spit extended before 1347 is uncertain. The first haven was cut in that year near Gunton.

Probably well before this time the spit had attained such a length or even longer, and Lowestoft Ness had been in process of formation for the same amount of time. If Gillingwater is right in saying the cliffs were reached by the sea in Roman times, there are about 1000 years or more in which to account for the growth of Lowestoft Ness.* Judging by the known growths of such shingle headlands as Dungeness, Orford and Scolt in England, Cape Carnaveral in the United States, and the Darss in Germany, this period is quite sufficient.

6. Lowestoft to Aldeburgh: Dunwich.

Continuing southwards from Lowestoft † there is a very interesting stretch of coast, along which many changes have taken place. Unfortunately, the exact history of these changes is lost. An old document, "The Butley Cartulary," throws much interesting light upon them. The original document (date 1237) is in the Bodleian, but Suckling gives a full account of it in his 'History of Suffolk.' ‡ The *raison d'être* of the document is the apportionment of wreck of the sea. From it, it would appear that all the small streams—Kessingland, Benacre, Minsmere, Hundred (Aldeburgh)—were then open and served as havens. These are now completely closed and their waters find egress by means of sluices or by percolation through shingle banks. In some cases, as at Easton, very beautiful broads are left, merely separated from the sea by a shingle bar. Perhaps the greatest alterations have taken place at Dunwich. § Dunwich, formerly an important mediæval city and possibly the seat of a Bishop, is now practically destroyed. In the days of its prosperity it ranked as a port of no small consequence, and was then situated at the head of an estuary formed by a shingle bar. The small Dunwich river joined the Blyth, and both shared a common but variable mouth near the present position of Dunwich.

The history of Dunwich is the history of all the east coast havens; a haven constantly blocked by storms and liable to shift. There was also,

* *I.e.* about 1000 years before the Ness is first mentioned (*temp.* Ed. II.). *Vide* also Gillingwater, 'History of Lowestoft.'

† It is rather doubtful if Lowestoft Harbour was ever a true outlet for the Waveney through Oulton Broad and Lake Lothing. In storms the sea did occasionally break over the low land into Lake Lothing. Between this lake and the sea and between Lake Lothing and Oulton Broad are two glacial ridges. This lowlying area was probably the place known as Kirkley Haven. (See 'Lowestoft in Olden Times,' by F. D. Longe.) Wheeler ('The Sea Coast') thinks it was a former mouth of the Waveney.

‡ Suckling, 'History of Suffolk,' vol. 2, p. 305.

§ Steers, *Proc. Inst. Suff. Arch. and Nat. Hist.*, vol. 19, pp. 1–14, 1926 (for 1925).

as to-day, great erosion along the cliffs. Prior to 1328 the haven mouth was near Dunwich, but a great storm in January of that year blocked it up. This led to the usual trouble with Southwold and Walberswick before a decision could be reached where the new haven should be cut. Redman (*op. cit.*) has suggested that the new haven was Buss Creek, which lies just to the north of Southwold. There is, however, little reason to suggest this, because Gardner,* the historian of Dunwich and Southwold, makes no mention of it as a haven mouth. The mistake is due, probably, to reading leagues instead of miles,† for "Leucas. (At some earlier period Buss Creek was open to the sea, but it seems to have been closed before the thirteenth century.)

In brief, the history of the Dunwich coastline seems to have been, first, the development of a spit which deflected the River Blyth to the south. In course of time this spit attached itself to the cliffs at Dunwich and the waters within, either naturally or artificially, found egress where the haven stood prior to the storm of 1328. It is impossible to say, with any pretence to accuracy, what happened before that date, but it is reasonable to assume that this haven was not the first. Certainly many later cuts were made through the obstructing shingle, but none lasted for any length of time. In the eighteenth century the shingle seems to have been cast back on to the marshes, and since that time erosion has removed nearly the whole site of the old town.

From Lowestoft to Aldeburgh the coast is formed of soft sandy cliffs alternating with low shingle banks, sometimes capped by small dunes. There are two small "nesses," the one at Covehithe, the other at Thorpe. Both are small sand and shingle headlands which originated first as spits deflecting the Kessingland and Hundred rivers. Commencing at Aldeburgh is the greatest of the east coast spits—Orford Ness.

7. Orford Ness: Its History and Evolution.

Orford Ness is a shingle spit of pronounced cuspate pattern. Its length is about 11 miles. Orford Ness proper is the name given to the apex of the spit. The extreme south end of the spit is named North Weir Point, probably a corruption of North Eared Point, a name suggestive of its recurved nature.‡ Throughout its entire length there is scarcely any sand to be seen except at low spring tides. The shingle is piled up in orderly series of "fulls" or ridges. The intervening hollows are called swales or slashes. The spit, like Dungeness, grew out into comparatively deep water, and, up to the Ness proper, gradually receded farther and farther from the land.§ The former coastline is

* Gardner, 'History of Dunwich,' 1754.

† *Vide* New Eng. Dict., under "League."

‡ See 'Memorials of Old Suffolk,' p. 226, ed. V. B. Redstone. 1908.

§ The spit grew southwards: the old coastline ran more or less south-west from Aldeburgh. Hence, as the spit lengthened its distal end receded farther from the land.

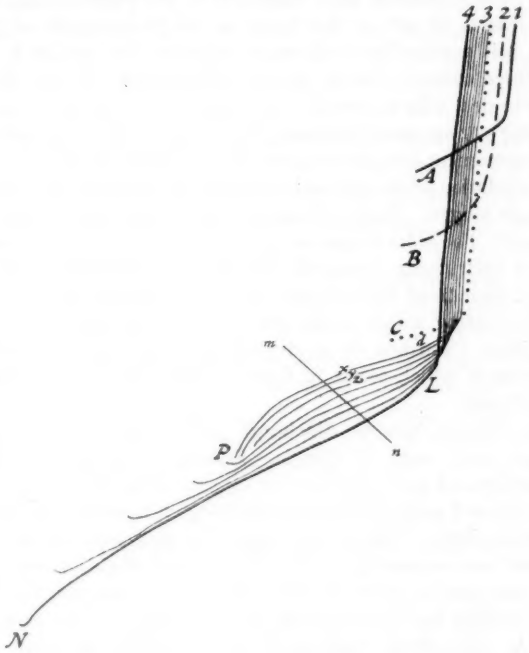
clearly marked by a line of high ground running more or less directly from Aldeburgh to Bawdsey.

Ancient maps and documents permit the study of the growth of this spit in some detail. The oldest known chart of this area is of the time of Henry VIII. (*c.* 1530). It is really a chart of the whole coast from the

5. *Sketch-map of Orford Ness, reduced from O.S. 1-inch map revised* 1905–07

Orwell to Gorleston, and seems to have been intended for use in coast-defence schemes. On this map the entrance to the river is shown just opposite Orford. The chart is very rough and unreliable. The next map (temp. Eliz.) suggests the haven entrance had shifted southwards

to a point midway between Boyton and Cauldwell Halls. A. Appleton's map of 1588 is very similar. In 1601 the area was carefully surveyed by Norden, who produced a large and detailed map of considerable accuracy. Here the haven entrance, allowing as far as possible for the inaccuracies of the earlier maps, is shown in much the same position as on the Elizabethan map. Saxton's (1575) and Speed's (1610) maps quite obviously represent the coast as it was at a much earlier period. They are very diagrammatic, and help little in the solution of the problem. Maps of the seventeenth and eighteenth centuries continue to show the



6. *Evolution of Orford Ness. No attempt is made to show exact number or orientation of ridges: there are* 40 *across m—n*

southward growth of the spit. In 1805 the first edition of the 1-inch Ordnance Survey Map was published. Bryant's map of 1824–25 is in close agreement with this. The next edition of the Ordnance Survey Map in 1838 shows further growth. The maximum length seems to have been attained in 1897. Between that year and 1902 storms cut off a considerable part. In 1923 the spit was growing once again.

Accepting the accuracy of Norden, and assuming the maximum length was reached in 1897, we have a growth of nearly 2½ miles in about

300 years (1601–1897), an average annual addition of about 15 yards. If we assume the relative accuracy of the Henry VIII. and Elizabethan maps we must also assume that the spit grew about four times as fast prior to 1601. This is improbable. But it is quite probable that Orford, which, like Dunwich, was once a thriving port, became important just about the time when the spit had extended far enough to be a protection and not a menace to Orford's Haven. Orford Castle was built in 1165, and then Orford was a prosperous port.* Physiographically, this period in Orford's history possibly coincided with the time when the spit had reached such a position as is indicated in the Henry VIII. map, and for this reason, as well as that based on the probable rate of growth of the spit, it is assumed that this map represents the coast as it was some two or three centuries before Henry VIII.'s time. If this be the case we have to deal with a growth of the spit of about 5½ miles in 700 years (1165–1897), or an annual leeward progression of about 13 yards, a figure in close agreement with the 15 yards since Norden's Survey.

The evolution of the spit can be traced by studying the disposition of the shingle ridges. Each individual ridge at one time formed the end of the spit. The older ridges are much less distinct than the newer ones, owing to their being gradually flattened by weathering and gravity. However, their trend lines are still quite clear because the larger pebbles, under the sorting action of the waves, tend to remain in the swales or on the ridges. Further, the swales and ridge tops are often well marked by vegetation, which seems to favour these parts of the ridges rather than the flanks.

From Thorpe Ness to Aldeburgh and on to Orford Ness there is really one main ridge of shingle. Several minor and parallel ridges are superimposed on it, but may be neglected for the present. As this ridge is followed southwards from Aldeburgh it is seen to cut off obliquely many older ridges. These older ridges are in groups (A, B, and C on map), and are comparable to the Marams and Hood at Blakeney. No definite date can be given for the time of their formation, but they were almost certainly formed before the twelfth century. The most northerly group, A, runs nearly south-south-west (*c.* 206°), the next, B, rather more to the west (*c.* 216°), and the third group, C, runs at an angle of

* (*a*) This is the more probable because a great number of the shingle ridges do cease at a place (Stonyditch Point) which corresponds approximately with the position of the south end of the spit on the Henry VIII. map. (See also Steers, "Orford Ness," *Proc. Geol. Ass.*, vol. **27**, 1926, pp. 306–325.)

(*b*) Balding and Turner, chap. v., 'Memorials of Old Suffolk': "Orford in 1164 was a thriving village, having a busy market-place. The erection of a castle increased its prosperity, and converted the once small hamlet of Sudbourne into one of the most flourishing of Suffolk boroughs."

(*c*) Redstone, chap. xii., *ibid.*: "When Henry II. built his castle at Orford in 1165 shingle had begun to collect at and upon the headland, Orford Ness. The town quickly developed from the small hamlet of Sudbourne to a thriving port, and finally to a flourishing borough ***standing at the very mouth of the haven.***"

c. 56° to the main beach ridge. In each separate group the more southerly ridges turn more to the west than the more northerly.

The greatest development of ridges, often more than forty in number, is found around the lighthouse. It is difficult to make any hard-and-fast divisions in this area, but the following groups may be distinguished :

1. The present Main Beach Ridge.

2. The ridges on the sea-side of the lighthouse, which are enclosed by the Main Beach Ridge.

3. The oldest ridges, which run behind the lighthouse and are cut off north of it by group 2.

In this third group the older are again cut into, truncated (at P on map), by the newer near Stonyditch Point.* Southwards from this point the ridges run in long open curves, and are more or less parallel to one another.

Still farther south, near the present position of North Weir Point, a large part of the spit, comparatively recently, was cut off by the sea. Subsequent to this truncation, there has been a further alteration by the addition of a modern appendage to the spit, possessing many excellent examples of recurved ends on its inner side.

The spit owes its formation to the combined action of waves and the longshore drift. The longshore drift here runs to the south, to all intents and purposes parallel with the spit. Hence it works in conjunction with waves coming from the quarter between north and east—from off the greatest fetch of open water relative to Orford Ness. Such waves would cause southward-directed beach-drifting. It is probably not possible to separate the effects of these two actions. T. W. Marsh † has seen sand drifting northwards here with the ebb and shingle thrown southwards by the waves. Arguing from analogy with the Norfolk coast, wave action would appear to be the dominant factor, but when waves and longitudinal drift act in conjunction it is not easy to differentiate between them.

Orford Ness began as a simple shingle spit across the mouth of the Alde. There is every reason to expect that such a spit would recurve landwards, and grow forward as a series of such landward-directed hooks.‡ But as the spit continued to grow in this way, it progressed as a whole, seawards. This can be seen from the map, the 50-foot contour marking approximately the line of the former shore (see also footnote, p. 37). But always, it must be remembered, the waves would be slowly driving the whole beach landwards. The interaction of these processes may be shown as in the annexed figure (6).

Suppose the continuous line 1 represents the spit at an early period in its evolution. The recurved ridge marked A corresponds to those

* This truncation makes a very fine angle with the older ridges.

† Vide *Proc. Geol. Assoc.*, vol. 36, 1925, p. 434.

‡ Johnson, D. W., ' Shore Processes and Shoreline Development,' p. 289.

marked A on the map. In course of time the spit lengthened and at the same time was driven landwards, as shown by the chain-dotted line 2. Corresponding to this are the recurved ridges B. Repetition of this process led to the formation shown by the dotted line 3 and the recurved ridges C. These particular ridges, C, correspond to those a little distance to the north of the present lighthouse. The next succeeding ridges to be formed were those marked *x*, *y*, and *z*. When the earliest of these was formed there was a well-marked bay-like conformation of the spit (see the line *dx*P). As newer bars were formed the bay-like conformation gradually disappeared, so that at the present time the outer line of the spit runs as shown by the line 4LN on Fig. 6. Near the place marked P the bars called *x*, *y*, and *z* are cut across obliquely by the newer bars. This is the truncation near Stonyditch Point, which has already been referred to. Many of the older bars end here.

The spit continued to grow southwards, but at the same time decreased considerably in width. The extreme end of this thin part was necessarily unstable, and was caused to recurve landwards by the waves. Fresh material, however, was still coming from the north, and directly or indirectly lengthening it. The combined effect, then, of the waves and the constant addition of new material produced the long tapering part of the spit, with its well-preserved recurved ends, south of Stonyditch Point.

Whilst the spit may owe its general formation to wave action and to the longshore current, certain modifications were probably brought about by other factors. The ness point (*i.e.* the lighthouse point) is at the place where material drifting alongshore from the north should leave the coast and try to continue its course in a straight line.* In calm weather some material may merely "creep" round the point, but in stormy weather the greater force of the waves and other factors should carry material farther south. Such material would later be driven shorewards, and built up by the waves into ridges of considerable length. That such is the nature, in part, of the ridges south of the lighthouse is corroborated by observations made on two visits to North Weir Point at the end of March and early in April 1923. In this period, not characterized by any bad weather, a new ridge had formed. It was about half a mile long and merged northward into the previous main beach ridge. It appeared to be due quite definitely to the constructive action of waves acting along its entire length rather than to simple longitudinal accretion.

The effect of winds on the profile of the beach is important. As elsewhere on the East Coast, the prevalent winds are from a point between south and west; the dominant winds from north-north-east and north-east. Hence, during a period of normal winds the beach "makes," but suffers very considerable erosion during strong north-easterly winds.†

* The orientation of the Whiting Bank strengthens the argument.

† This erosion is very marked between Aldeburgh and Orford Lighthouse.

To some extent the change in the trend of the beach which takes place at the Ness causes the southern part of the beach to have rather more protection from north-east winds. However, toward North Weir Point the trend of the spit is again more nearly north and south, and so this part is exposed to north-east winds. Furthermore, the spit is here very thin, and often, as in 1897, great masses are cut off from the spit and piled up on the marshes at Shingle Street.*

Here there is an enormous amount of shingle, a good deal of it stabilized. It is worth noting that the great masses taken from the spit in 1897 were hurled on to that already existing at Shingle Street so as to enclose a deep lagoon, which was still in existence in 1923. Shingle banks protect the flat marsh lands from here up to Bawdsey Cliff. The shingle is still in transit southwards, and a small but very changeable bar runs across the mouth of the Deben. The beach is continued on past Felixstowe, and at Landguard Point, which has been well described by Redman,† there occurs another great shingle expanse showing the typical recurved forms. From this point on to the Thames shingle gradually lessens in amount.

8. The Origin of the Shingle.‡

A great deal of detailed work yet remains to be done on the East Coast, especially on north Norfolk. The origin of the shingle has always been a puzzle. Analysis shows that quite 99 per cent. of it is flint. The remainder consists of various resistant rocks, especially igneous rocks of Scottish facies and to a lesser extent Scandinavian igneous rocks. There are also occasional fragments of sedimentary rocks to be found, probably in part from the Jurassic beds of the Yorkshire coast. At present it is impossible to say precisely where this shingle comes from, but the gravels of the glacial beds which occur along nearly all of the coast must have supplied a great part of it. Further, boulder clay and other glacial sediments must have been left on the floor of the North Sea and may supply a good deal. The fact that most of the shingle is flint apparently points to an origin not far distant.

The full effects of winds, tides, and waves on this coast are not yet known with any precision. On the very shallow bottom off north Norfolk the tidal currents are very complex, due especially to the Wash and to the numerous small creeks and channels. How far the movement of shingle and sand is responsive to these and other effects is a problem only to be decided by future work.

* When a high spring tide occurs during a period of south-east winds, the level of the water in the North Sea is raised and is ponded back in the river, causing floods. Havergate Island has been almost completely flooded on at least two occasions on this account in recent years.

† *Op. cit.*

‡ See A. K. Coomaraswamy, "Sources of Pebbles on Blakeney Point," in Blakeney Point Report. 1915–16, pp. 14 and 15.

Before the paper the PRESIDENT (Dr. D. G. HOGARTH) said: We are to hear Mr. Steers on a subject which is probably very near to a good many of our hearts; that is, the erosion of the East Anglian coast between the Wash and the mouth of the Thames. I am an East Coast man myself and was born almost within sight of one place, a little to the north, where erosion has been very severe, namely, Spurn Head. I have no doubt others present will listen to the paper with the same interest as I shall.

Mr. Steers then read the paper printed above, and a discussion followed.

Prof. F. W. OLIVER: It is a singular thing that Mr. Steers should be the first person who has ever, to my knowledge, visited Blakeney Point for study other than as a bird man, a botanist, or a biologist. Times without number I have asked geological colleagues why they will not come to Blakeney Point and see how the many things which interest them when they become encumbered by subsequent layers are actually built. They go and dig in the ground and by sections imperfectly make out the buried topography which is all exposed to the observer on the surface in such places as Blakeney Point and Scolt Head. But in Mr. Steers, inspired by geographical ideals, we have the first man who has ever come to take advantage of the very evident facilities which such spots afford.

I know the coast of England pretty well, having walked round almost the whole of it, and the opinion I reached was that Blakeney Point should be the kindergarten of all shore study where building up is involved. I do not mean denudations and so forth; but wherever shingle, sand, and mud are involved, being separated and being thrown into *quasi* permanent beds, they are in the simplest way to be appreciated at Blakeney Point. Mr. Steers has pocketed his pride and come to the kindergarten, and that is an event in the history of Blakeney Point.

As regards what Mr. Steers found there and his observations, I personally am perfectly prepared to accept them, provided no other factor not yet apprehended should turn up. What I suppose interested him was the fact that here were two pieces of land both pointing west, growing and accreting at the westerly extremity, Scolt Head and Blakeney Point. Then he discovered that the tide flowed in different directions. Whilst the tide washes Scolt Head from east to west, it washes Blakeney Point from west to east at the period of the tide that matters, and involves the highest shingle. The demonstration of this is his particular achievement. I entirely agree with his data as far as they go, and I hope they will be extended. He has now put forward a provisional theory—and after all every theory is provisional—that it is what he calls the dominant wind from the north-east that matters chiefly in shingle drift. As regards violence and velocity of wind, of course that is not so. Last New Year's Day I recorded wind from the west at Blakeney Point blowing at 68 miles per hour, and we do not get that from the north-east, at any rate in my experience. On this theory, then, the north-easterly waves coming with a long fetch out of the North Sea more than neutralize those generated by offshore winds, which of course are the prevalent ones. The balance represents the potential powers of growth of the spit in a westerly direction.

[Prof. Oliver then showed a series of slides illustrating why Blakeney Point proved such a good kindergarten. The first depicted the transverse travel of the beach in the landward or southerly direction, whilst a second group of slides showed the development of the Far Point, which had not existed prior to 1912, but of which a history as complete as could reasonably be expected had

been collected by repeated instrumental surveys during the last thirteen years. The speaker pointed out that the main beach advanced like an amœba over the salt marsh, the pseudopodia, or talus fans, consisting of shingle cast over the crest by master tides which rose in north-westerly gales higher than expectancy, such tides being the ones which brought about the most evident change. The talus fans were somewhat scattered because the shingle was obstructed by lines of Suæda bushes growing on the beach, directing the flow of the shingle towards certain points. If the whole beach were properly afforested with this plant there should be no travel of shingle. In the next slide the new shingle fans were seen at a steep angle which had not gentled down as it would do in eight to fifteen months. Another slide depicted the sea face of the same beach, the principal features being an outcrop of mud, such outcrops being visible only on the very rarest occasions, though that shown was observed for about ten days and found to contain fossils, or rather mummified seeds and rhizomes, of the marsh plants growing in the days when the spot was a salt marsh on the other side of the beach. According to the data collected during the past twenty to twenty-five years it had taken the beach two hundred years to travel its own width, assuming it to have always progressed at the same rate.

With reference to the Far Point Prof. Oliver pointed out that it was a continuation of the main shingle beach and consisted of successive shingle spits. He then showed an interesting series of charts illustrating the development of this new system of shingle beaches, from 1913 to the present day, remarking that they could be taken as a fairly accurate history of the development of broad facts, the only chart drawn in free-hand being that for 1917, when, owing to the war, it was not considered prudent to use instruments. Continuing his comments on the paper, Prof. Oliver said :]

As regards the source of the materials going to the production of Far Point, that no doubt, is planed off the whole length of the bank. If one took its length as 7 miles and planed shingle off for a depth of 6 inches and 100 feet wide, and imagined it travelling west, it would work out at 70,000 cubic yards, which is of the order needed for these recent developments. It is evident waste is going on, and that it is not being made good further back, because there is nowhere at the present time whence such reparatory materials can be derived.

Mr. F. DEBENHAM: Any remarks that I can offer come from one who is merely a colleague of Mr. Steers in the School of Geography at Cambridge University rather than from one who has given very much study to coastal erosion. But from my memory of such works as the Commission Reports on the Coastal Erosion of the East Coast and one or two other papers on the subject, I believe Mr. Steers is the first man who has really withdrawn emphasis from the tides and added it to the winds. I think I am correct in saying that the majority of writers have said the tides have done most of the work of distribution, and that the winds are a minor factor. If I understand Mr. Steers' paper correctly, I think he is putting it the other way about. From a general study of erosion, apart from coastal erosion, one would be much inclined to follow him. One could quote quite properly the analogy of changes in land form in arid regions, where you have year after year wind erosion, frost erosion, and gravity changes going on, but which may be swept away in perhaps half an hour, or entirely altered by the single rainstorm they get every few years. The coast of Peru and Chile is an excellent example. If you study the erosion—either from maps or photographs—of the land forms on that very arid coast you are at once struck by the fact that it is typical flood erosion. I think Mr. Steers means somewhat the same thing when he speaks of the

north-east wind which, though less frequent and powerful, is the dominant wind, because of its direction, and it may well be the chief factor in forming the spits. I should certainly tend to believe that theory. I am not sure I would not go a good deal farther and say that what is really of importance is single individual storms. I do not know whether Mr. Steers has actually measured the effects of an individual storm, but it seems to me that that might very profitably be a basis for further research. For instance, those "fulls" and swales at Orford Ness and those curious recurved points at Blakeney Point tempt one to refer them to something catastrophic and individual rather than general continuous movement of the shingle. Perhaps Mr. Steers would not agree, but it strikes one that since there are individual ridges one may look for an individual cause, in point of time.

Mr. Steers did not say very much with regard to the recurved ends. They occur, as one sees from the photographs, particularly at Blakeney Point and, somewhat blunted, at Orford Ness. If they were all like those at Orford Ness, just a few yards at the end of the long ridge, I think one could accept them as the product of a swirl; but when they curve back and finally go in the opposite direction to the main outer drift of the shingle, as at Blakeney Point, one ought to ask for further explanation than mere swirl. Perhaps Mr. Steers can say what they are caused by. Mr. Steers has been naturally led to study the history of the coast, and that in itself is a form of research which is needed, and he has put very conclusively the extraordinary changes which are of such immense local importance, especially as regards Dunwich and Orford, the former now being a tiny village, whereas it once had both a bishop and a port. I am sorry Mr. Steers did not have time to tell us something about the way in which he is working at the problem and the methods he is using for studying the mechanism of these drifts. One would like to hear and probably like to question the measurements which he is making; whether, for instance, he is concerned much with the disposition of the sandbanks offshore, which one would, at first sight, say had a good deal to do with the force, if not the direction, of the drift. I conclude by congratulating Mr. Steers on his exposition of an important and very interesting series of changes in the East Coast of England.

Mr. R. D. OLDHAM: I should like to remark that the idea of the drift of shingle being mainly caused by waves and not by tidal currents is by no means so new as the last speaker has suggested. It is some while since I first began to learn geology, yet in those days I was taught that the drift of the shingle along the shore was entirely due to the storm waves and not the tidal currents, and I have seen nothing since to modify that conclusion in any way. The tidal currents are nowhere strong enough to move shingle, but the waves are. When it comes to sand and mud, it is another matter, and Mr. Steers' observation of the opposite drift of the sand and the shingle is interesting and, I believe, new.

There is one question I would like to ask him: whether he has at all considered the question of the effect of any change of level that may have taken place? I think there is, round the English coast, very clear suggestion that there was a considerable lowering of the land relative to the sea in the thirteenth century. It was the time when Winchelsea was overwhelmed, when the Goodwin Sands were overwhelmed, when the Zuyder Zee was formed, and there are other facts pointing to the conclusion that the level of the land or the sea was unstable, and that there was a lowering of the land relative to the sea. In the case of the shingle spits, this would have the effect of complete or partial submergence, and this might account for the discrepancies in the rate of growth which Mr. Steers noticed, as between the older and more modern records.

Mr. J. A. STEERS, in replying, said: I was very glad to have Prof. Oliver's support on what I said with regard to Blakeney Point and Scolt Head and to waves being the dominant factor in their westward growth. I might say, *apropos* of Mr. Oldham's remarks in connection with waves and tides, that as far as my work goes I have been fully aware that both of these agents were at work. Either waves or tidal currents or both may be the chief factors in building a shingle spit. My point was that so far as I am aware no very definite suggestion had been made, beyond that in the map in Wheeler's book, as to how Blakeney and Scolt spits had been formed. With regard to the East Coast in general, one sometimes sees statements to the effect that the tidal drift is to the south, the inference being that Orford Ness and other spits are due to the southward-directed tidal drift. I think the tidal drift is an important factor. But I feel that waves are even more important, not only at Orford but on the Norfolk Coast as well. Then Mr. Oldham raised a point with regard to a possible depression of the land in the thirteenth century. I believe, in so far as Winchelsea and other places are concerned, that their destruction has been suggested by others to be due not so much to subsidence as to greater storminess at that time. I think I am right in saying that Brooks and others have suggested that the thirteenth century was a period of greater storminess than the period which preceded or has followed it, and the changes Mr. Oldham mentioned might conceivably be due to that rather than to actual subsidence, I am, however, unable to say anything very definite on that point.

Mr. Debenham raised one or two points regarding the formation, spacing, and length of ridges at Orford and other places. I cannot be certain, but from what I have seen I am rather inclined to think that these ridges are generally built in calm weather, and that in storms certain parts of the beaches are eroded. The several visits I made to the end of Orford Ness seemed to show that long ridges were not so much the product of longitudinal secretion, but were due rather to the constructive action of waves along their entire length; and I think that is the case elsewhere. It is difficult to say anything definite about the spacing and length of beach ridges. There is, I think, one important factor coming in, but I do not know how it works. At Orford the proportion of shingle to sand is very high: practically speaking, there is no sand. The eastern end of Blakeney Point is almost entirely shingle, but as you go westwards a great deal of sand, especially at the mouth of the harbour, is found exposed at low tide. In a general way the proportion of shingle to sand lessens as you go westwards. There is comparatively little shingle on Scolt Head, but in each case the long ridges and recurved ends are definitely built of shingle, though they may have dunes on them. I can only suggest that there is some connection between the proportion that the shingle bears to the sand and the shallowness of the sea, which determines the length and the spacing of the ridges because not only does the proportion of sand increase at Blakeney and Scolt, but also the water there is shallower than at Orford. At Orford, along the entire spit there is comparatively deep water offshore. At Blakeney, where the shingle is most abundant there is the deepest water. The secondary recurving of the lateral ridges is the work of waves at high water within the main shingle banks.

I am afraid I cannot at the present moment enter into a discussion on the methods of research I have employed. I regard this paper only as a start. I want to continue the work further and obtain further data. I hope some of the results are of interest.

The PRESIDENT: We have had an interesting paper and a very clear exposition of what has evidently been a very careful piece of work. We must

congratulate Mr. Steers and science on the fact that he has found out that "kindergarten" at Blakeney Point, and that he will probably visit it again. We had hoped to have been addressed by at least two other gentlemen from Cambridge; but restriction of the London and North Eastern Railway Service is apparently accountable for the fact that only Mr. Debenham has been able to get here. We are very glad, however, to have had him. I am sure you wish me to thank Mr. Steers on your behalf for his interesting account of what is a very vital matter to us all. Any one who knows North Norfolk realizes how serious coastal erosion is. My own College at Oxford has a large farm there and is very anxious. If any one who played golf at Brancaster in the early part of the century (as I have) plays there now he will realize what an extraordinary change may be produced in a landscape. I am sure you all hope that Mr. Steers will be able to return to the East Anglian coast and confirm or revise the conclusions which he has put before us to-day. I ask you, therefore, to signify your gratitude to Mr. Steers in the usual form.

Dr. J. S. Owens sends a written contribution to the discussion, of which the following is a summary:

In fixing when change in direction of tidal currents occurs the times of high water do not seem to me to have much bearing upon the question, as they represent the arrival of the wave crest, whereas the current determines the eddy. Doubtless the exact position of change varies. Float tests are affected by wind drift, not so much of the float itself, as of the water.

Mr. Steers has hardly done justice to previous investigators of tidal currents and beach drift. The writer's book* on coast erosion, published in 1908 with Mr. Case, deals at some length with the preponderating effect of waves over tidal currents for coarse materials. That the upper part of the foreshore is acted upon by the flood current only is pointed out, and the difference in the behaviour of sand and shingle under the action of waves and currents. The wandering of a channel in sand is well known, and is due to the interaction between the sand and the water. Harbour engineers know that while the ebb current cuts a definite channel in an estuary, the flood cuts across the ebb channel, and spreading wide makes subsidiary channels. Dr. Owens does not agree that the motion of shingle under wave and current action is very imperfectly understood, and thinks there is no general explanation which would apply to all cases. A very important factor governing the growth of sand spits is drift by the wind. Experiments this summer showed that a wind of 15 to 20 miles per hour can pick up damp sand between tide marks and transport it at the rate of about 18,000 tons per mile per week.

The experiments were made near Gore Point, which the author refers to as "another shingle spit subject to violent and rapid changes." It is not a shingle spit, but sand; nor is it subject to violent and rapid changes. The point has for some years been steadily eroded.

Mr. Steers replies that current observations confirm the tide table as showing that the flood current runs east at Blakeney and west at Scolt. Careful records of all details of float tests were made, and he is confident of their accuracy. He knows Dr. Owens' work well, but thinks that in East Anglia little is yet known of current effects. The wanderings of tidal channels in sand are not comparable with the major changes dealt with; and wind-blown sand is not important on shingle spits. The reference given to Gore Point speaks of frequent changes and an inner and outer range of shingle banks.

* 'Coast Erosion and Foreshore Protection,' by John S. Owens and Gerald O Case. St. Bride's Press: 1908.

THE ALASKA BOUNDARY DEMARCATION

Major E. W. Nesham, D.L.S.

Read at the Meeting of the Society, 14 June 1926. *Map follows p. 96.*

[*The demarcation of the Alaska boundary was finished not long before the outbreak of the Great War, and that is no doubt the reason why no narrative of the operations has ever been given before at a meeting of this Society, though a technical paper on the Survey methods, and a sketch-map of the country north of the Porcupine River, were published by Mr. Douglas Nellas in the* Geographical Journal *for January 1913. The account of the general operations which follows is by a member of the Canadian Party, Major Nesham, now of the Gold Coast Survey. Major Nesham's lecture was illustrated by a large series of coloured slides, but the colouring makes it impossible to reproduce them as half-tone blocks, and the negatives are not available.*—Ed. *G.J.*]

A TREATY between Great Britain and the United States of America signed in 1906 provided for the demarcation and survey of that part of the Canada–Alaska boundary which follows the 141st Meridian. The Boundary Commissioners—Dr. W. F. King, Chief Astronomer of the Department of the Interior for Canada, and Mr. O. H. Tittmann, Superintendent of the Coast and Geodetic Survey for the U.S.A.—immediately started work on this survey. Their task was to project a line from the Mount St. Elias Range to the Arctic Ocean.

The first conference of the Commissioners was held at Washington, D.C., on 23 November 1906 and following days. The principal points agreed were, that as a Joint Party had observed for longitude on the south bank of the Yukon River in 1906, and as the agreed longitude of the observing pillar was 9 hours 24 minutes 00·027 second west from Greenwich, or 17·62 feet west of the true meridian of 141° west from Greenwich, the initial point of the boundary-line should be located in accordance therewith; that an accurate azimuth should be observed by a joint party at the initial point, and a mark set determining the direction of the boundary, which should be produced to the north and to south; that the line should be projected with the micrometer theodolite and marked by large and small aluminium monuments set in rock or concrete at intervals of 4 miles, more or less, and intervisible, if possible; that the position of such monuments should be controlled by a belt of triangulation extended along the boundary, and a vista 20 feet wide should be cut through all timber encountered; and that a topographical map, scale 1/62,500, should be made of the country not less than 2 miles on each side of the line.

It is impossible in the short space available to describe in detail a survey which took eight years to complete, but a general description of the country and of the conditions of survey can be attempted. To bring

to a successful conclusion the survey of a line approximately 700 miles long through country so varied, much of it unexplored, where the average "season" was only one hundred days, required perfect organization, efficiency of equipment and the enthusiastic cooperation of the *personnel* comprising the two parties.

The work was divided, the United States party carrying out triangulation and topography generally, whilst the Canadians undertook the placing and tying in of monuments, line measurement by stadia between the monuments, vista cutting, and photo-topography. The line projection was carried out by a joint party.

Precise levels were brought up from tide water at Skagway, Alaska, to the boundary at White Pass by the United States surveyors, and carried *viâ* the White Pass Railway, Whitehorse–Dawson waggon route, and the Dawson-Glacier waggon road and pack trail to station G South, on the 141st Meridian, a distance of 491 miles.

Conditions of supplies and transport had been greatly improved since Mr. Wm. Ogilvie was first sent to fix the meridian on the Yukon River in 1887. The White Pass Railway train was now taking eight hours to cover the same distance it took seven weeks to cover in 1887; Dawson City with its wharfs, hotels, and telegraph had been built; while river steamers ran fairly regularly between Nome, Alaska, and Whitehorse in the Yukon Territory. The establishment of base camps was simplified because many rivers, some navigable by river steamer or launch, crossed the line.

In order to get *personnel*, horses, and supplies to the various starting-points along the line two motor launches, each 40 feet long with an 8-foot beam, were designed to draw about 14 inches of water, unladen. They were both of the stern-wheel type, the Canadian launch having an engine of 25 horse-power, while that of the American craft was slightly more powerful. The launches drew 18 inches of water when loaded, but could carry very little freight in addition to their own fuel and supplies, but each launch was capable of hauling a 35-foot barge carrying about 8 tons. In addition to these two launches the Canadians chartered a small launch for carrying mail and for freighting, as it could handle a small barge carrying about 2 tons of supplies. The Americans hired another stern-wheel launch similar in pattern to the first two. During the seasons of 1911 and 1912 the launches made a total of 30,000 miles, distributing men and supplies to base camps and dumps on the White, Ladue, Black Porcupine, Yukon, and Old Crow rivers, whenever a sufficient depth of water was available, usually in the spring or when the snow on the higher hills melted in July.

As the work progressed other means of transport were brought into use, besides the pack trains which distributed supplies along the line or moved camp: dogs for summer packing as well as for spring or winter sleigh hauling; single-horse sleighs; back-packing by men; rafting

downstream; man sleighs; and scows man-handled upstream. Waggons were used in 1909 and 1913 to take parties into the White River country; but spring conditions were so bad that such a journey was very slow indeed.

In 1909 it took about three weeks to get to Canyon City on the White River from Whitehorse. The first nine days were spent on a "waggon road." On this the waggons often went into deep mud holes, and then all hands and horses were needed to get the outfit on to hard ground again. Deep snow, where trail had to be broken; no snow at all, where waggons had to be taken over by double teams; and rotten ice on Lake Kluane, were some of the incidents on this trail. At the crossing of the White River on May 21 the last ice bridge collapsed only half an hour after the last team had passed over.

The horses selected for the pack trains of the Canadian party were range horses, bought in bunches, unbroken, from the ranches of British Columbia, the American horses being similarly bought in Washington and Oregon. These horses were used to rough conditions and lived and thrived where stall-fed animals would have died. To feed a hundred horses with hay and oats would have made the cost of the survey prohibitive, and although many tons of feed were freighted to base camps, it was sparingly used, mostly in the spring and fall. Much good grass was found along the rivers and in burnt-over ground, even inside the Arctic Circle, in addition to which willow tips and pea vine varied the fodder. As it was impossible to take the horses out of the country for the winter season, they were herded out on the pea-vine covered bars of the White River. The hardiness of the breed enabled many to winter, but casualties were heavy, and new stock was brought in each spring to fill up the pack trains. It was found necessary many times to night-herd the horses, as, should camp have been pitched in a locality where feed was poor, the animals would wander back to the last good feeding-ground or would range over a wide area in search of grass. From this cause the projection party of 1911 was held up for two weeks. Picketing was of course out of the question, as the only feeding-time was during the late evening or early morning, and any curtailment of liberty to range in search of food would quickly have left the party without horses.

Supply dumps had to be made animal-proof as far as possible. Usually four trees, a suitable distance apart, were chosen, cross-pieces lashed to them at about 12 feet from the ground, and a platform of poles made on which the supplies were "cached" and covered by a tarpaulin. Pieces of tin were nailed around each supporting tree to keep down small tree-climbing animals. Bears proved the worst nuisance. One huge brown or grizzly bear managed to rob a cache placed over 10 feet above ground. Everything was destroyed or eaten—even some cement in sacks. The loss of this cache meant short rations for some time, and we hoped sincerely that the cement had caused the brute indigestion.

Fresh meat was obtained in some form or other all along the line. Moose were seen as far north as the Firth River. Woodland caribou ranged to the Old Crow River, while between the latter river and the Arctic Ocean barren land caribou were shot. White sheep (*Ovis Dalli*) were seen at intervals all along the line, especially in the neighbourhood of the White River, where many hundreds were observed in small bands. Fannen's sheep were found only on one range about 40 miles north of the Yukon River. Goats, though plentiful in the neighbourhood of the meridian, were not encountered on the line of survey. The hills of the Skolai River, about 55 miles west of the line, proved to be a regular goat pasturage. Black, grizzly, and brown bear were shot, the latter of great size, one track measuring 14 inches. A bear of this species treed a packer for several hours, while another was seen chasing the pack-horses, and traces were found of a caribou carcase covered with moss by these animals. On another occasion one was seen chasing a young sheep in the slush ice. Bird-life was plentiful. Ptarmigan above timber limit, bush partridge or willow grouse in the valleys, and many different waterfowl in the low-lying swamps near the rivers, especially in the Yukon Flats near Fort Yukon, where the valley of the river broadens out and immense tracts of marsh country give sanctuary to innumerable waterfowl during the breeding season.

Many specimens were collected for the museums, and a geological reconnaissance of the whole line was made.

As the conditions of survey, and the country over which the line passed, were more or less the same throughout, with the exception of the extreme north and south ends, a general description will suffice. The country was undulating, the hills rising to mountainous, generally with deeply eroded stream-beds. Heavy timber was usually encountered in the valleys, while the summits were bare or at best covered with a sparse growth of stunted timber or low bush. Many deep, wide game tracks were found and used as trails; where new trails had to be followed ridge tops were favoured except in the more mountainous country, when the valley bottoms furnished the best route. The thick "Caribou" moss overlying almost the whole of the lower country made progress very difficult and tiring. Wood and water for camp use were everywhere plentiful.

The long days of these high latitudes aided the work materially, particularly on the more northerly section. The length of the season being short, the day's work was long, especially for helio-parties and photo-topography.

Mosquitoes were plentiful, but by using evil-smelling preparations or "dope" and the mosquito bar by day, and by sleeping in mosquito-proof tents by night, the discomfort caused by these pests was minimized. Dope might be anything from oil of citronella to bacon grease. The mosquito bar was worn over a broad-brimmed Stetson hat and tied

under the arms to keep it in place; a hole was provided through which a pipe could be smoked. Casualties, through the smoker lighting his pipe carelessly and setting fire to his mosquito bar, were fairly numerous. These bars were uncomfortably hot; but anything was better than the constant irritation of myriads of flies and mosquitoes. At night smudges were made of green brushwood and moss thrown on a fairly bright fire. This proved the best method of keeping away the insects at night. The horses, however, were often so bothered that they were unable to rest or feed, and were seen in the morning on some high rocky ridge up in the wind, from which place it sometimes took hours of patient toil to get them down again. It is impossible to describe the effect on the "cayuses," as the horses were called, when the first animal covered from ear to hoof in a mosquito blanket appeared amongst them.

In 1907 a joint party travelled to the boundary from Dawson City on horse-drawn sleighs over the river ice, which means, under spring conditions, a succession of rough ice, snow drifts, and surface water. As rough ice will upset a sleigh and snow drifts have to be dug through, while water causes feet to freeze, it can be easily seen that progress was not swift.

This party observed for azimuth, and on the arrival of the main body in June the projection and survey of the 141st Meridian was begun. The method of projection used has been fully described, with the precise-level results, in the paper by Mr. D. H. Nellas.

The first permanent marks on the boundary were two large pyramidal bronze monuments which were set on either bank of the Yukon River. From here the line runs southwards across the watershed of the Forty-mile river to the Sixty-mile river, where a check-base was surveyed.

In 1908 the helio men of the projection party ascended the White River as far as Canyon City in small boats. The usual method of propelling a small boat up one of these swiftly flowing rivers is by poling, but survey parties unfortunately cannot be made up of river experts alone, so the method adopted by the surveyors was to pull the boat up by ropes. Often the only route was by the bed of the stream, which, when it is taken into consideration that ice was generally still on the river-bank in the spring, was by no means a pleasant experience.

From the "check base" already mentioned the line was continued over a spur of the Wrangell Mountain and across the White River to the foothills of the Natazhat Range.

The projection party had left the slower-moving parties far behind, and in 1909 a big combined effort was made to complete the Yukon River–Natazhat Range section before the end of the season. Fifty-one men and eighty-three horses were sent in overland from Whitehorse to Canyon City, a journey which took three weeks to complete.

During this season an attempt was made to climb Mount Natazhat from the south, but weather conditions were unfavourable. A further

attempt was made at a later date to climb this mountain, and the following extract from the official report (dated 11 August 1909) may be interesting:

"The trail led over the divide on glare ice, where steps had to be cut for nearly half a mile. . . . It began to snow, but we had to go on, as it was impossible to recross the divide in the storm, and reached camp at 8.30 worn out and chilled to the bone, found the tent down, and everything wet or frozen. . . . During the night it snowed 25 inches, and continued snowing the greater part of the next day. Even with the oil stove burning full blast and three men in the little 7 by 7 tent the thermometer registered only 32°."

During this season a reconnaissance had been carried out up the Porcupine and Black Rivers by motor launch to prepare for the next. This was the first time the sound of a power boat had been heard in these waters. The line had also been projected north from the Yukon River for 40 miles.

In 1910 the line was projected from this point across the two branches of the Black River and over a succession of plateau-like ridges to Rampart House on the Porcupine River, where the horses had to swim across one at a time tied to a canoe. No chances could be taken, as the rate of work depended largely upon the number of horses.

The trading post occupies the buildings put up in 1891 by a survey party sent in to fix the Meridian, and there was much discussion as to which side of the new boundary-line the building would be. When it was known that the post was on Canadian territory the Union Jack was hoisted and the occasion duly celebrated. The projection party put their horses, six in number, on a scow and floated the 225 miles down the river to Fort Yukon in four days. Soon after this snow fell and the Porcupine River began to freeze.

No effort had ever been made to bring supplies up the river by power boat, and a new era for transport in these regions began when in 1910 the first Survey steamer arrived with 50 tons of supplies. News, even in the thinly populated north, travels fast, and a motley gathering of natives with their dogs greeted the Survey steamer in 1911. The handling of 150 unbroken horses, the "bronco busting," and shoeing caused intense excitement and considerable amazement. The shoeing puzzled them. Why should horses need iron shoes? "Moose and caribou do not need them." The first Indian on a horse's back was a local hero for several days.

The line-projection party reached the British Mountains about 25 miles from the ocean, having carried the line across the Old Crow flats, the Ammerman Mountains, and the Firth River. The final projection was not carried through until 1912.

In the meantime small-pox had broken out amongst the Indians at Rampart House, and the survey was much hampered through the Quarantine Regulations which were enforced by the R.N.W. Mounted

Police. The party was given a wide berth by the Indians in 1912, as they blamed it for the small-pox epidemic of the previous year.

Preparations had been made to complete the survey of the northern section, and the last monument was placed on the Arctic shore. Topography was extended 6 miles to the east and 15 miles to the west along the coast. Franklin's Demarcation Point was found to be about 7 miles west of the Meridian. It had formerly been the winter rendezvous of the Eskimos of this district, but was abandoned for Herschel Island when the whalers made the latter place their headquarters. The ruins of their old huts, or barabaras, still remain. The point is not a prominent feature, as it is merely a long narrow sand-spit. It does not project out to sea, but simply forms a narrow barrier extending across Demarcation Bay.

Few Eskimos were seen by the parties. One family was encamped at Clarence Bay. With true Eskimo hospitality the man invited the survey party to share his frugal repast of tea and fish. He took great pride in showing his family treasure, such as a broken alarum clock and a trunk which he appeared to value very highly. Tundra runs parallel with the coast-line, and near the last monument it is about 15 miles in depth. Here mosquitoes dwell in their millions. No shortage of firewood was experienced, and even on the shore itself driftwood was available in large quantities.

The launch parties during their trip up the Old Crow River discovered Mastodon remains, of which rumours had reached us. Many tusks, teeth, and bones were brought away as souvenirs. There are doubtless many more such tusks buried in the sands of the river-beds in the vicinity.

It was considered impossible to project a line over the Natazhat Range, as the line crossed at an elevation of approximately 12,000 feet, over perpetual snow and ice. Triangulation was therefore carried out in 1912 from the end of the White River system of 1909 across the Skolai Pass, south and up the Valley of the Chitina River to the line. A base-line was measured in the Nizina Valley and much topography done up the Anderson Glacier. All was now set for the season of 1913.

A Canadian party went into the White River at Canyon City following the old 1909 trail. Their work was, if possible, to tie in the 141st Meridian survey with the South-Eastern Alaska Boundary survey by climbing Mount Natazhat and observing Mount St. Elias. The attempt to climb the mountain was successful after two failures, but clouds came up quickly and no result of any real value was obtained. However, by connecting the topography to the head of the Anderson Glacier by means of photo-topographic stations westward up the Klutlan Glacier, and then up a long narrow glacier which ran in a southerly direction near the line, the topography of the whole line was completed. The elevation of Mount Natazhat is 13,500 feet.

The equipment selected for all the parties working on the snow- and

ice-covered mountains between the Nazahat Range and Mount St. Elias was selected for its durability and lightness in order to meet the conditions of glacier travel. The tents were after the pattern of those used on the recent Antarctic expeditions, and could be set up by a single alpine-stock. Eider-down sleeping-robes, alcohol-burning stoves, and Eskimo "Parkas"—a smock-like garment the hood of which is trimmed with fur—and the usual mountain-climbing gear were taken. The staple food of the climbing party was baked beans in tins. Chocolate was used during the actual ascent. The lack of water, other than that from melted snow, caused great discomfort. The party on the Mount Natazhat climb were unfortunate, as their ice-axes had not arrived from Vancouver. This party freighted their supplies on sleighs, three men to each sleigh, up the Kutland Glacier to the southern slopes of Mount Natazhat, occupying camera stations *en route*. By the last week in May they had back-packed their tents and instruments up to about 10,000 feet. Here the camp was pitched on a small plateau overlooking a sharp drop many hundreds of feet on to a glacier. From here a climbing party of four managed to get on to the ridge with the instruments; but a sudden storm, such as is known to all climbers of high altitudes, drove the party down when within a few hundred feet of their objective. The instruments, including a 6-inch theodolite, tripod photo-topographical camera and plates, etc., were left on the top. Camp was reached late the same evening, but the storm increased in severity, and snow fell for three days. Small snow slides became frequent, and it was decided to descend to a camp at a lower level, not however before a slide had nearly pushed the tents and their occupants over the edge of the precipice. The trail down crossed a very steep snow slope where, on the upward journey, a hard crust had made climbing easy. This crust was formed by the melted snow freezing again during the night, and usually retained its strength for some time after sunrise.

Now however, with 2 feet of newly fallen snow, the journey down became one continuous flounder in soft snow, and the party was nearly smothered by miniature snow slides. A second attempt to climb this mountain from the lower camp, at about 8100 feet elevation, was successful on June 18, the climbers starting before dawn when the snow surface was hard.

At about 11,500 feet however, after the sun had made an impression on the crust, when the climbers were on the long steep slope near the top of the ridge, a big snow slide took place. The first three men on the rope were swept down, but fortunately the fourth man was outside the line of the slide, and held fast. It was decided to go on over the track of the slide, and many anxious glances were directed up that slope before the top was reached. About seven hours were taken to climb the ridge. The instruments were found buried under 5 feet of snow. From this point deep snow made travelling very laborious, and on reaching a

prominent snow dome it was decided to leave one of the men, who was suffering from his feet, to occupy the point as a camera station at an elevation of about 12,400 feet. Storm clouds had been gathering for about an hour, and it was realized that the chances of taking any observations on the summit were small. It took three hours' hard work to complete the climb to the summit.

The view from the ridge had given impetus to the ever-increasing desire to gain the summit, but, almost coinciding with the arrival at the top, clouds and snow flurries completely spoiled the view. To the north could be seen the rolling tree-covered dark green hills with rivers winding like silken threads in and out of their sheltering valleys, while to the south lay the great snow-covered mountains which stretched range upon range as far as the eye could see and seemed to bar farther progress southward. A few beetles were seen lying frozen on the surface of the snow, and at 11,000 feet a small green humming-bird was picked up, but no other sign of life was seen, not even moose, after an elevation of 8000 feet had been reached.

The other Canadian and United States parties spent the season in the country between the Anderson Glacier and Mount St. Elias. The line was projected across the valleys at the head of the Chitina River, Mount St. Elias was connected by triangulations, and topography carried beyond the boundary for 25 miles up the Logan Glacier. The attempt to climb Mount St. Elias failed. Striking south from the Logan Glacier across 50 miles of snowfields the party eventually arrived at the foot of the mountain at an elevation of 9500 feet, and back-packed their supplies and instruments up to a camp at 13,500 feet.

The following is extracted from the Report:

"Looking to the south from this camp we could see below us the great Malaspina Glacier, and beyond it the Pacific Ocean. The Yahtse River was plainly visible, and in the sunlight, with every streamlet flashing, it suggested an arm of the sea. Icy Bay was also a noticeable feature, and stretching away to the west was the Coast Range at about our own level. Turning to the north, we could trace our route over the snowfields as far as the Logan divide. Beyond there appeared on the horizon Mount Wrangell and Mount Blackburn, and many other snow-covered peaks rivalling them in height, while one sharp peak in particular, seemingly more distant than the others, was very conspicuous. In every direction we could see a hundred miles or more, except to the north-east, the west shoulder of St. Elias cutting out the view there. It rose abruptly from camp 3000 feet, while farther to the right, 3 miles distant and 4500 feet above camp, stood our goal, the terminal cone of the mountain.

"Rising at midnight on June 29 to get an early start for the final dash, we found that a dense fog had filled the valleys, and storm flurries were in evidence about the summits. Before an hour had passed snow

began to fall, and it was midnight of the following day before the sky cleared, and even at that early hour the sun was lighting the summit of St. Elias. The instruments, food, and extra clothing were made up into packs, giving each man about twenty pounds, and about one o'clock a.m. the ascent was begun.

"Although cameras were taken along, the difficulties of the first part of the climb proved so engrossing that picture-making was forgotten entirely. We scaled a succession of cliffs, which one of the men declared were so steep that he was leaning backwards most of the time. Hands were used quite as much as feet, and to secure a firm grip on the rocks mittens were often removed, and although we were not aware of it at the time, several finger-tips were frostbitten. When outcrops of rock were not being traversed, the route lay over ice slopes where the cutting of steps was necessary.

"After nine hours of difficult climbing we were within a few hundred feet of the top of the west shoulder, and the rest of the climb to the summit appeared to be over a gradual slope presenting no obstacles. Four of the party only were feeling slightly the effects of the altitude, and all were confident of making the remainder of the distance, when a storm, such as is known only at high altitudes, overtook us. At first we were loath to admit that it was anything but a slight flurry, and continued the ascent. It soon became evident, however, that it was to be of more than temporary duration and that even if the summit were reached instrument work would be impossible, and so, at an elevation of a little over 16,000 feet, we reluctantly turned back.

"The descent was accomplished not without considerable danger, and great care was necessary to keep our footing, and in one place one of the men, who had been weakened by mountain sickness, slipped on an ice-slope and was well started on a swift glissade, when one of his companions below stopped him. Camp was finally reached at five in the afternoon.

"Rations were now very low, and, in order to make it possible to attempt another ascent, three of the men, who had been most affected by the rarity of the atmosphere, were sent to the base camp. Three others remained with me to await fair weather, but the storm continued unabated. We rolled ourselves in our robes for warmth, and only ventured out about once in every twelve hours to eat a little rice and bacon. At midnight of the 3rd of July the bacon was gone, and only a handful of the rice remained; eighteen inches of snow had fallen, and it was still coming down. The last hope of scaling Mount St. Elias had vanished, but we still hoped to be able to secure a round of photos at camp-level. About 3 a.m. the clouds suddenly raised, and a camera station near camp was occupied. Then packs were made up and we hastily descended to lower altitudes."

By a rather fortunate coincidence, the highest camp occupied by the

party on their attempted ascent of Mount St. Elias was on a small spur of the mountain on the western side, and the camera-station "Elbow" occupied by them while there was shown by the computation to be only 128·2 metres west of the 141st Meridian. The Commissioners therefore decided that the point of intersection with the Alaska Coast boundary should be on the meridian at the latitude of this station, the last course of the south-eastern boundary thus being from the summit of Mount St. Elias to a point on the meridian in latitude 60° 18′ 22″·29 north. Three monuments were set on the sides of the Logan Glacier and two south of Mount Natazhat on the Klutlan Glacier. The monuments had all been numbered, No. 1 being on the shore of the Arctic Ocean.

Although the survey in the field naturally takes first place, the value of the work done in the office by the computers and draughtsmen must not be overlooked. The distances and stations occupied will serve to show the magnitude of the office work: Projection, 557 miles; triangulation, 518 stations occupied; topography, 5938 plane-table and 210 photo-topographical stations occupied; geodetic levels, 510 miles; vista and stadia, 556 miles; monuments set, 202; bases measured, 7; azimuths observed, 3; magnetic stations, 197; geodetic positions determined, 609.

Maps on the scale of 1/62,000 were printed, 38 sheets in all, each sheet covering 15 minutes of latitude; the Arctic Coast being on Sheet No. 1.

During the whole of the survey no fatal illness or accident occurred, and such was the personal popularity of the two chiefs that no extra inducement, such as increase of pay, was ever necessary to get men for the survey parties. The trouble was to pick who was to go.

Before the paper the PRESIDENT (Dr. D. G. HOGARTH) said: We are met to-night to hear an account of work done rather long ago—that is, before the War—but of which no general account has been given to this Society or, I believe, publicly at all in this country. I refer to the laying out of the boundary of Alaska, the boundary between British and American territory. It was laid out along a meridian line, as not uncommonly happens in the New World, that is to say, it was drawn straight with the ruler. I believe the lecturer will tell you that that, odd and unnatural as it may appear, was the best and almost the only way in which the boundary could have been laid out, a good deal of the country being practically without any outstanding feature. Major Nesham was concerned in demarcating that boundary, which had been delimited by the report of the Commission. He is to conduct us from the Pacific Ocean on the south to the Arctic Ocean on the north. He has had very considerable experience of those northern regions of which we heard a good deal not long ago in Mr. Lambart's paper on the ascent of Mount Logan, and he will take us over something of the same ground. Furthermore, he has had the opportunity of studying the very remote Eskimo who wander in that country. I will ask Major Nesham to give us his account of a most interesting region very ill-known to most here, as it is to myself.

Major Nesham then read the paper printed above, and a discussion followed.

Sir REGINALD TOWER: All that has been told us in the lecture to which we have listened with so much interest this evening is quite new to me and probably to most of those present. I can add very little to what has been said; in fact, I can only go upon what happened before the survey was undertaken. The little that I have had to do with the Alaska boundary consists of three parts: First, when I was in the Embassy in Washington I was attached in 1898 to Lord Herschell's staff on the Joint High Commission which met in Quebec, where we remained for a couple of months with the Canadian Ministers and several distinguished Americans forming the Commission; among whom were Mr. Fairbanks, afterwards Vice-President of the Republic, Mr. Foster, Mr. Coolidge, and other distinguished Americans. Lord Herschell had as his colleagues the Canadian Ministers, headed by Sir Wilfred Laurier. We sat in Quebec during the summer, and when it became cold we adjourned to Washington. The work went on there for a considerable time until, unfortunately, the proceedings terminated by Lord Herschell's much-regretted death. That was in 1898, and in the following year, when Lord Pauncefote (Sir Julian Pauncefote as he then was) was summoned to the Hague to take part in the Tzar's Disarmament Conference, I was left to draw up something in the shape of a temporary settlement, because the condition of the Alaska boundary between Canada and the United States had become so urgent that there was serious apprehension lest something might occur between the people on the two sides of the line. My work with the U.S. Secretary of State, Colonel John Hay, is something I can never bear sufficient testimony of gratitude for, because when I first went to him he said, "This is a very urgent matter. We must make something in the shape of a temporary line, and at once. We must not have any interruptions; we must do it as quickly as we possibly can. I therefore hope that you will come to my house whenever you like. Come in the evening after office hours, and let us begin at once." That is, I think, a model for Secretaries of State. His courtesy was such as I have never experienced either before or since. The line was drawn in an arbitrary way, chiefly dealing with the southern part that has been shown us on the map, where the greatest danger was likely to be experienced. That formed the *modus vivendi* which was signed in Washington and which, as far as my memory serves me at this moment, stood until the Alaska Boundary Tribunal was formed and sat in London. Again I was appointed as Secretary, and therefore was able to see and know all that was going on in this Commission, being appointed by the two sides, the British and the Americans.

I well remember that the first incident which occurred which seemed likely to injure the good relations between England and the United States was that I had been instructed to have printed on the official notepaper "Alaska Boundary Tribunal." The Americans sent for me and said that the designation was wrong; that it was "Alaskan Boundary Tribunal," the Alaskan being an adjective. I submitted this to the Foreign Office, and they said, "No, its name is 'Alaska Boundary Tribunal,' and so it must remain." The result was that, as Secretary of the Tribunal, when I reported to the Foreign Office it was the Alaska Boundary, and when I reported to the Americans it had to be Alaskan Boundary, and thus both were perfectly satisfied.

I can only now be proud of having played a little part in the matter. The Award of the Tribunal was made; that was embodied in the Treaty, and it is the Treaty which formed the line which we have seen this evening, with those dreadful mountains and difficult country through which our lecturer has taken

us. All I can say is that if I had to work in that connection again I would rather do the job that I had in London and Washington than go over those precipitous mountains, even with the interest that such a journey must have had. I thank the lecturer very much, and I am sure that would be the wish of others, for the interest he has given us in his lecture this evening.

Capt. H. W. SETON-KARR: It may interest this audience to know that about forty years ago I made the first attempt to ascend Mount St. Elias. I was accompanied by Lieut. Schwatka (late U.S. 9th Cav.) and Professor Libby (afterwards the Secretary of the American Geographical Society). It was then thought to be the highest mountain in North America. Our cook was a man called Dalton, who afterwards discovered the pass into the Yukon, since called Dalton's Pass.

The PRESIDENT: As there are no other speakers, I have only to convey to Major Nesham, in your name, your very cordial thanks for the interesting evening which he has given us. I said at the outset that the country was very ill-known to me—how ill-known I have learned as the paper went on; for I must admit that almost every picture was a surprise. I do not know whether it was an equal surprise to you that the country to the north, on the Arctic Ocean, should appear to be much more possible for human habitation than that in the south on the Pacific. I think you all must have appreciated the enormous amount not only of physical labour that was involved in the demarcation of the boundary but also the immense amount of organization necessary to convey a party of that size through the country. More people were probably moving in that survey party than ever moved together in the country before. I wish Major Nesham had shown us rather more of the Indians and Eskimo, of whom, I believe, he has made a special study; but perhaps he will do that for us on some other occasion. At any rate, I offer our cordial thanks to the lecturer.

A LOCAL SUBSIDENCE OF THE GULF COAST OF TEXAS

Douglas W. Johnson and Wallace E. Pratt

IN 1917 a prolific oilfield was developed near the mouth of Goose Creek, a small stream flowing into Galveston Bay not far from Houston, Texas. During 1918 and subsequent years millions of barrels of oil were removed from beneath the surface of the Goose Creek area. Beginning in 1918, it became apparent that Gaillard Peninsula, near the centre of the field, and adjacent low coastal areas were becoming submerged. Elevated plank roadways or walks were built from the mainland to the derricks, and the derrick floors had to be raised. Vegetation was flooded and killed, and finally all of the peninsula disappeared beneath the waters of the bay.

Along the northern and southern margins of the oilfield cracks appeared in the ground, sometimes running beneath houses, across streets, and through lawns and gardens. These cracks persisted, and recurrent movements along them resulted in dropping the surface of the ground on the side of the cracks toward the oilfield. The total maximum

subsidence is now more than 3 feet, and the area affected $2\frac{1}{2}$ miles long by $1\frac{1}{2}$ miles wide, the longer axis running approximately east–west.

In America submerged lands belong to the State, and only the State can grant oil and gas leases on such lands. Consequently, when Gaillard Peninsula became submerged, the State claimed title to it and sought not only to dispossess the owner and the oil and gas lessee, but also to recover from them the value of the oil and gas removed from the premises subsequent to the time when the land became submerged. The question was taken into court, and in the final decision the claim of the State of Texas was denied. The basis for the decision was the court's acceptance of the contention that the subsidence at Goose Creek was not the result of natural processes, but was caused by an act of man, namely, the removal of large volumes of oil, gas, water, and sand from beneath the surface. No act of man can operate to deprive another man of his property under the law. If the subsidence of Goose Creek had been a natural process, "an act of God," then under the American law title to the submerged land would have passed to the State, and property worth millions of dollars would have been lost to the owner of the land and to the operating companies. As it is, the owner and operators continue to enjoy the rich returns from this important oilfield.

Inasmuch as subsidence of the Earth's surface due to the exploitation of oilfield appears to be an extremely rare occurrence, if indeed the Goose Creek case be not unique in scientific literature, and further, inasmuch as the Goose Creek case affords an excellent illustration of the solution of an important legal controversy by the use of geologic and physiographic data, a brief statement of the essential facts may be in order. The senior author was retained as consulting physiographer in connection with the court proceedings mentioned above, and studied the phenomena of subsidence in the Goose Creek region. The junior author's acquaintance with the region was gained in his capacity as Chief Geologist of the Humble Oil and Refining Company, lessee of Gaillard Peninsula.

The geological formations involved are relatively recent, mostly Oligocene or later, and consist of loose sands and clays only slightly more compacted than sea-bottom muds. All of the sand layers are lenticular in shape, and occur isolated in the clays, so that oil or water does not pass readily from one sand-bed to another. Some oil is encountered at a depth of 500 feet below the surface; but the bulk of the production is from depths of 1000 down to 4100 feet. It is important to note that the Goose Creek field does not appear to be located on a salt dome of the ordinary type. No salt has ever been encountered in drilling, although centrally located wells have reached depths greater than 5000 feet.

Numerous benchmarks were established throughout the Goose Creek region some years ago, and these have been re-surveyed and new bench-

marks established at intervals since the original survey. We thus have precise figures showing amounts of subsidence at something like eighty points in the affected area and its immediate vicinity. Sufficient accurate data are thus available to show clearly the essential fact that a local "dishing" of the Earth's surface has occurred in the Goose Creek region, the central area of greatest subsidence corresponding approximately with the centre of the oilfield.

The disturbance certainly has no connection with the supposed gradual subsidence of the Atlantic and Gulf coasts which many geologists and laymen believe to be in progress. General changes of level affect large areas rather uniformly, and, so far as known, never show such sharp differences of rate of sinking within short distances as characterize the Goose Creek region. The greatest rate of subsidence admitted by most geologists for the East Coast of North America is 1 or 2 feet per century; whereas the sinking at Goose Creek has amounted to more than 3 feet in eight years. The surveys demonstrate that the disturbance at Goose Creek rapidly dies out to nothing in all directions from the centre. These facts show how impossible it should be to confuse the sinking at Goose Creek with the phenomena of general coastal subsidence.

The Goose Creek disturbance is equally unrelated to the rise of mean sea-level observed at Galveston by the United States Coast and Geodetic Survey, and amounting to about 6 inches in the period 1917–1923. W. B. Dawson, of the Canadian Tidal Survey, and G. T. Rude, of the U.S. Coast and Geodetic Survey, have shown that mean sea-level may vary from year to year by an amount which sometimes exceeds a foot. These changes are due largely to meteorological and astronomical causes, and occur in cycles of several years' duration. The senior author of the present paper has shown that mean sea-level may also change with changes in the form of the shore-line, natural or artificial changes in the size of inlets, deepening of channels into bays, and other alterations of a local character. Careful study of the conditions at Galveston would probably indicate that the changes reported there are of a temporary nature. In any case, the reported change in sea-level at Galveston is so small as compared with the changes at Goose Creek as to make clear the fact that they are not related. Furthermore, it should be noted that since all measurements in the Goose Creek area are referred to fixed benchmarks on the land, and not to tide-gauges recording mean sea-level, the changes at Goose Creek are not only independent of, but are in addition to, any supposed changes indicated by the Galveston records. The Goose Creek sinking certainly has nothing to do with any real or apparent changes in the average level of the sea.

Erosion of clay coasts by waves or currents frequently produces local subsidence, with cracking and displacement of the surface far back from the actual shore. The Goose Creek disturbance clearly has no relation to such a process. The fact that the subsidence is distributed indifferen tly

over both land and water areas, and that low marshland on Gaillard Peninsula has suffered equally with the higher clay uplands, is against the wave or current-sapping theory. If any subsidence were to occur in this region due to wave or current action, it should be along the more exposed neighbouring shores where conditions are in all respects more favourable ; but no such changes of level are known in these areas.

The Goose Creek depression cannot reasonably be interpreted as a sink-hole formed by the solution of limestone, salt, or other soluble formation in depth, under natural conditions. Neither limestone nor salt is encountered in the drilling of the wells. If the Goose Creek oilfield is developed over a salt dome, the salt occurs at depths greater than 5000 feet. In any case, the solution theory can be applied, if at all, only by recognizing that artificial exploitation of the oilfield brought about conditions favourable to rapid solution, as by creating a vigorous circulation of water which did not previously exist.

In our opinion the cause of the subsidence is to be found in the extensive extraction of oil, water, gas, and sand from beneath the affected area. The purely local character of the disturbance, the facts that the area of subsidence coincides with the period of extraction, and that continued extraction is accompanied by continuing subsidence as shown by the latest measurements, all point unmistakably to this conclusion. These points will be considered in order.

Subsidence is purely local, and its area corresponds closely with the area of extraction. The oil wells cover an area that is rudely oval, with the longer axis east–west ; and the contours of equal subsidence exhibit the same pattern. The centre of maximum subsidence is near the centre of the drilled area. Where groups of wells reach out beyond the average perimeter of the field, there is a distinct extension of the zone of subsidence into the areas of extended drilling. The location of earth fractures near the margins of the field, one on the north and one on the south, with the down-drop in each case toward the centre of extraction, is highly significant.

The time of the subsidence corresponds with the time of extraction. Prior to the development of the oilfield in 1917 no indications of subsidence appear to have been noted in this area. Then came the opening of the oilfield, and a year later the subsidence became evident. In eight years the change of level amounted to 3 feet. A closer coincidence between time of subsidence and time of extraction could not be imagined.

Continued extraction is accompanied by continuing subsidence. This is made apparent by recent surveys. In the year 1924–1925 the maximum subsidence was 0·25 foot near the centre of the field, the amount decreasing outward in all directions until areas of absolute stability were found about the margins of the affected district.

It is safe to say that the aggregate volume of oil, gas (at 1000 lbs. per square inch pressure), water, and sand removed from Goose Creek since

1917 will exceed 500,000,000 cubic feet. This is several times greater than the calculated volume between the planes representing the present surface and the former surface of the Goose Creek field. In other words, the cause seems amply sufficient to account for the observed result.

It has been noted that the coastal plain beds at this locality consist largely of unconsolidated clays, and that the oil sands occur in discontinuous lenses. Under such circumstances the removal of oil and water from the sands is not followed by a free flow of water into the pore spaces from distant localities, because the compact nature of the clays, which completely surround and isolate the sand lenses, prevents such ready flow of water. The pore spaces are therefore occupied by water draining in more slowly from the adjacent clays; and it is a well-known fact that the draining of clays causes them to become more compact. This, in turn, would permit subsidence of the overlying surface. Other important factors, undoubtedly, are the reduction of pressure in the sand reservoirs from values of 1000 or 1200 lbs. per square inch to atmospheric pressure, and the actual removal of sand itself from the reservoirs. In the reduction of moisture content, escaping gas has been of material importance. These factors have combined to produce a draining and a drying of the clays, with consequent shrinkage; and in the absence of competent beds to support the overlying deposits, the results have become apparent in a remarkable dishing of the surface in the Goose Creek field.

THE MILITARY GEOGRAPHICAL INSTITUTE OF CZECHO-SLOVAKIA

Major M. N. MacLeod, D.S.O., R.E.

THE opening of the new offices of the Military Geographical Institute at Prague last year is an event in the history of European geography and cartography which may serve as the occasion for a short account of the aims and accomplishments of the youngest of national survey departments. Founded in November 1918, the Institute has had many difficulties to surmount. Before the Great War all the cartographic services of the old Austrian Empire were concentrated in Vienna, and the new republic, when it came into existence, found itself nearly destitute of material from which to construct its national survey department. No machinery or equipment whatever was available, nor any suitable building, while trained technical personnel was very scarce.

The first quarters of the Institute were a private house at Ujezd. From this it moved in 1919 into the Budovec School, and soon afterwards into some buildings in the old Arsenal. These were quickly outgrown, and in 1921 the Institute overflowed into the Stefanik barracks at Smichov. Meanwhile, new offices had been under construction, and were ready for occupation in 1925. The Institute, after its many flittings, is at last

permanently housed in a specially designed building which should excite the envy of its more mature cousins in older countries.

Occupying an area of 4600 sq. metres, the new building provides, on ground floor and four stories, 20,000 sq. metres of useful floor space. The printing offices, included in the above, are in a separate *annexe* in the courtyard, an arrangement which frees the drawing and computing offices, as far as possible, from noise and vibration.

The exterior is plain but imposing, while the arrangement of the interior has evidently been thought out with care; it is claimed that the photographic studio is different from any hitherto constructed, and is superior to that of the Institute at Vienna. A room for geophysical measurements, completely isolated and equipped with arrangements for maintaining a perfectly uniform temperature, has been provided in the basement.

The Institute is at present directed by Col. Karel Rausch, and is organized in seven sections, as follows: Astronomy and Geodesy (Lieut.-Col. Dr. Ladislav Beneš); topography (Col. Alois Hlídek); cartography (Lieut.-Col. Matěj Semík); reproduction (Lieut.-Col. František Kostrba); military statistics (Col. Jiří Čermák); administration (Lieut.-Col. Rudolf Krčmář). There is no separate section for levelling, which is included in the work of "Astronomy and Geodesy."

The data and map material with which the Institute now deals are of course inherited from the old Austrian Empire. The surveys were executed more than forty years ago and are now seriously out of date, more especially in the industrial regions, where changes have been greatest. For the Czecho-Slovak republic the problem of maintaining an adequate revision of the national maps on a strictly limited budget is at present complicated by the fact that all the names on the old Austrian maps were either Germanized or Magyarized. There is a very natural desire to restore them to their native Czech as soon as possible, and without necessarily waiting for the sheets to be revised in the field. This is very largely a question of cartography and reproduction, and the Institute is to be congratulated on the progress made in spite of the severe handicap imposed by its numerous moves before settling into its present quarters.

No attempt has been made to alter the sheet lines of the old Austrian Series, though at some time or other this may have to be done, as the large-scale sheets are on a polyhedric projection, and therefore not adapted for "gridding" on the rectangular system demanded by the modern soldier.

Five separate series of maps were taken over from the Austrians at scales of 1/25,000, 1/75,000, 1/200,000, 1/300,000 and 1/750,000. In addition to maintaining these series, either by revision or redrawing, the Institute has in hand some 1/10,000 and larger scale work, and two sheets of the "Carte Internationale du Monde" (N.M33 & 34). It proposes also to commence shortly a new map of the whole country on Lambert's

projection (presumably Lambert's Conical Orthomorphic) on a scale of 1/500,000. This map will replace the present 1/750,000, which is regarded as provisional. It is the old Austrian Staff map on Bonne's projection, and covers the territory of Czecho-Slovakia in nine sheets. It is being published now only in semi-skeleton form without contours or hachures.

Considerable changes, very much for the better, are being made in the large-scale maps. On the 1/25,000, in addition to revision of names, the sheets are being redrawn and published in two colours. On the new sheets the old black hachures are replaced by brown contours at 5-metre intervals with every fifth contour thickened. The new 1/75,000 differs less from the old in that hachuring is retained for the ground forms. The map is printed in one colour only, water and lakes being shown by "waterlining." The drawing of this and the ornament—in fact, of the whole map—is beautifully done, and the reproduction—apparently by photo-etching—is admirable. These new sheets of the 1/25,000 and 1/75,000 are excellent maps of which the Institute may well be proud.

The 1/200,000 series is not so satisfactory. It is printed in four colours, hill features being shown by brown hachures. The reproduction is very good, but the sansserif type used for the names is not beautiful, and the map is, in places, inclined to be overcrowded.

As regards field work, good progress has been made with the revision on the scale of 1/25,000, and certain small areas are being, or have been, surveyed on a scale of 1/10,000. Other large-scale surveys are projected. An interesting feature of the field work is the use which has been made of photogrammetry. A photogrammetric "Brigade" was formed in 1923, and some statistics of the results of its work are given in the Annual Report of the Institute for 1925.

In one case, in close gently undulating country, the out-door work (including triangulation) for a 1/10,000 survey of 36 sq. kilometres took 35 days, and the office work (using the Stereoautograph) 124 days. It is estimated that the total time of 159 days in this case is no less than would have been required for an ordinary traverse survey. In another case, where the ground was much accidented, the out-door work required 54 days and the office work 97 days: a total which is estimated to be two months less than would have been required by other methods. Some emphasis is laid on the importance of doing photographic surveys as far as possible in winter when the trees have shed their leaves.

The conclusion is that the value of photogrammetry depends on the amount of relief, on the visibility, and on the scale. It is considered that photography in close gently sloping country is useful only for very large-scale work. This is probably correct as regards photography from ground stations, but it is precisely in such country that the value of taking the camera into the air is likely to be most apparent. The Institute does not yet seem to have made any use of aerial photography, but it

evidently hopes not only to do so, but to effect substantial economies in the cost of revision by this means. Whether this hope will be realized remains to be seen. Reports of any work of this kind which may be done by so practical and enthusiastic a staff will be read with interest in this and other countries.

THE JUBILEES OF THREE GEOGRAPHICAL SOCIETIES

THE year 1926 has been prolific in Jubilees of our sister Societies. In March the Real Sociedad Géografica of Madrid celebrated its fiftieth anniversary (*Geogr. Journ.*, **67**, 553), and in November the three Societies of Antwerp, Brussels, and Copenhagen. Our Society was represented in Belgium by one of its Vice-Presidents, Lieut.-Col. Sir Francis Younghusband, and in Denmark by one of its Honorary Secretaries, Colonel-Commandant Jack. We are indebted to these representatives for the following brief accounts of the proceedings.

The celebration of the Antwerp Society was held at Antwerp on Saturday, November 6. A large meeting was held in the afternoon at the Opera House with Maître de Cock, the President, in the Chair. He delivered an eloquent address welcoming the delegates from the different Societies and setting forth the main activities of the Society during the fifty years of its existence. General Gouraud, representing the Société de Géographie of Paris, gave a history of French colonization in North and West Africa since 1876. Sir Francis Younghusband followed with a description of British colonial expansion in South Africa, and Colonel Liebrechts completed the story with a description of Belgian activity on the Congo. At the close of the proceedings General Gouraud was made an honorary member of the Society (he already had received the Gold Medal), and Gold Medals were conferred upon Colonel Liebrechts and Sir Francis Younghusband. Every delegate was presented with a beautifully illustrated catalogue of Belgian cartography in the sixteenth, seventeenth, and eighteenth centuries. In the evening a banquet attended by about 400 members and delegates was given, and was attended by the Prime Minister of Belgium, the Minister of the Colonies, and the President of the National Bank. At the banquet Sir Francis Younghusband presented an address of congratulation from the Royal Geographical Society.

On Sunday, November 7, the Royal Geographical Society of Brussels celebrated the fiftieth anniversary of their foundation. A general meeting was held in the afternoon, at which the President of the Society delivered an able address summarizing the geographical results of the last fifty years. Addresses of congratulation were then delivered by the

delegates of other societies. At the invitation of the Society Sir Francis Younghusband gave an account of his mission to Lhasa in 1904, and was offered the distinction of " Membre d'Honneur " by the President. In the evening the delegates were entertained at a banquet by the Society, and later in the evening a reception was given by Baron Lambert.

Owing to the marriage of H.R.H. the Crown Prince during the same week, the King of the Belgians was unable to honour either the Antwerp or the Brussels Society with his presence. But His Majesty, before the Royal wedding had been fixed for the week already settled upon for the Societies' celebrations, had expressed his intention to be present and his cordial interest in the proceedings.

To the celebrations at Copenhagen Norway, Sweden, Finland, Germany, Spain, and Great Britain had sent special delegates. The proceedings began at 1.30 p.m. on November 17 with a meeting at the University. After a short address of welcome by the President of the Royal Danish Geographical Society (Vice-Admiral Wandel), the foreign representatives and various local representatives of the University, scientific societies, etc., in turn offered the congratulations and compliments of their respective Societies. After this the President announced that the Danish Society desired to make all the representatives of other Societies who had done them the honour of attending the celebrations, Honorary Members of their Society ; and diplomas conferring Honorary Membership were then presented to the representatives. The proceedings terminated with a lecture by Prof. Vahl on " The participation of Denmark in Arctic Explorations."

In the evening a banquet was given to the foreign representatives and other visitors at the " Royal Skydebane," the headquarters of a shooting club which has been established for over 170 years, and in which the custom is that the winner of the annual shooting competition shall have a picture painted on his target, which is then hung in the building. The walls and some of the ceilings are covered with these targets, dating from 1752.

On the 18th the visitors were conducted to the famous collections of Egyptian, Greek, and Roman antiquities in the Glyptotek, and at 7.30 there was a large meeting in the Oddfellows' Hall, at which the King and the Royal Family were present. Before the meeting His Majesty received the foreign delegates, and desired them to convey to their respective Societies his personal thanks for their attendance.

At the meeting the President gave a short address of welcome ; the Secretary, Major-General Castonier, related the history of the Society ; and Dr. V. Madsen gave an address on " The Evolution of Greenland," illustrated by lantern slides and moving pictures. After the meeting the visitors and ladies of the Society were entertained at supper at the Hotel Phönix.

THE VEGETATION OF NORTH AFRICA

Carte Phytogéographique de l'Algérie et de la Tunisie, publiée par ordre de M. Maurice Violette, Gouverneur-General de l'Algérie. Notice par le **Docteur René Maire,** Gouvernement General de l'Algérie. Service Cartographique. Alger: Baconnier Frères. 1926. Pp. 78. *Coloured Map on scale of* 1 : 1,500,000. *Sixty Illustrations.*

THE title of this publication does not give a wholly adequate impression of its contents. The map is in the pocket of a bulky pamphlet which contains a discussion of the principles upon which it is based; an account of the flora of the area represented; a bibliography; and a long series of illustrations which, though not well reproduced, are of great interest and bring out admirably the outstanding features of the vegetation. More emphasis might, we think, have been laid upon the text, so briefly dismissed on the title-page, for the map is by no means self-explanatory. For example, an almost continuous coastal strip from the west of Bizerta to far to the west of Bougie is indicated as being occupied by the cork oak, while a somewhat narrower inland belt, including the singularly treeless area round the town of Constantine, is coloured with the light green tint which marks the holm oak formation. Generally, those familiar with the area represented will find difficulty in reconciling the facts as they saw them with the map, and others might be led seriously astray. We must confess indeed to a fear that the map may be reproduced in diagrammatic form in text-books and atlases, and give rise to quite false impressions as to the forest resources of the region. In the opening paragraphs of the text Dr. Maire explains the origin of these apparent anomalies by setting forth the purpose of the map. The aim which has guided him and his collaborators, he says, is to indicate the vegetation which would have normally covered the soil if nature had been allowed to work unimpeded, without direct or indirect interference by man. The map is stated to represent the broad lines of "climatic vegetation," that is, vegetation as influenced by the climatic factors. The point is illustrated by a discussion of the conditions in the Mitija plain. At the present time that plain is occupied, almost throughout, by cultivated crops; but an examination of small areas which have remained almost untouched by man, and of the floral succession in areas allowed to relapse from cultivation, lead him to believe that it was originally covered with low forest with wild olive and *Pistacia lentiscus* as dominants. In consequence, on the map the cultivated plain is marked as occupied by this formation. The map, in other words, represents deductions and not facts of observation.

Whether the working out of such a scheme on a small-scale map is possible in an area where man's influence has been so prolonged and so great is perhaps a question for the botanist; we need only note in passing that the author's illustration appears to evade some of the problems concerned. The present cultivated crops of the Mitija are of very recent origin, and the difficulty in tracing the antecedent vegetation cover is thus small. But some have thought that the presence of wild olive and lentisque in Algeria is a proof that there was a still earlier type of cultivation, including the characteristic Mediterranean fruit trees, that is, that the olive-lentisque formation itself is a secondary and derivative one and not primary. When the author speaks of "quelques coins priviligiés ayant échappé plus ou moins à l'action de l'homme" here he seems to have in mind man during the period since the French occupation, and to leave out of account possible earlier human influence. Without attempting to elaborate such points we feel it necessary to emphasize the fact that there

is nothing on the map itself to indicate that the colouring is not a guide to existing conditions, and that therefore it should not be used without a previous careful study of the text.

The main value of the map to the geographer is necessarily that it emphasizes the influence of the broad climatic factors, especially the rainfall conditions, and that, assuming that the limits drawn for the different subdivisions are " natural " and not excessively generalized, it serves to supplement the available climatic statistics. In the text there are a number of interesting notes on the possibilities of economic utilization of the areas marked as occupied by the different formations.

The area mapped is divided into two regions, the Mediterranean and the Sahara. The latter is however practically not discussed, and is left chiefly blank on the map. The Mediterranean Region is subdivided into three Domains. Of these the first, the Mauritanian Domain, is characterized " climatically " by the development of forest. It is subdivided into five Sectors, chiefly on the basis of differences of rainfall. The best-watered section is the Numidian, consisting of a small part of the north coast of Tunisia and of that of Algeria to a point some 50 kilometres east of Algiers. This is characterized, at least in theory, by the enormous development of the cork oak, and is in sharp contrast to the Public Section in north-east Tunisia, where *Zizyphus lotus* is characteristic, and the flora has a strong eastern element.

Into (2) the Mauritanian Steppe Domain falls the inland area with a continental climate and a small and irregular rainfall. A number of sections are again recognized. The general feature is that the climate is not well suited to forest growth, " which has taken refuge in the relatively well-watered mountain areas, where it is represented only by types requiring little water and heat." In (3) the Domain of the High Atlantic Mountains is included the region where elevation increases rainfall, while at the same time the temperature conditions exclude the more delicate forms. The most striking tree is of course the Atlas cedar, but this is accompanied by a number of endemic forms and by many interesting " relict " plants from the cool temperate zone.

In addition to showing the limits of the different domains and their subdivisions the map indicates the distribution of fourteen plant formations. It is interesting to note that no less than twelve of these have trees or shrubs as dominants. Of these twelve, again, seven have broad-leaved trees or shrubs as dominants and five gymnosperms. Among the broad-leaved trees the oaks give their names to three separate formations, that of *Quercus ilex*, that of *Quercus suber*, a tree always tending to disappear, and that of the deciduous forms, *Q. afares* and *Q. lusitanica*. So far as actual area is concerned, even on the method adopted, the regions occupied by such true forest trees are much smaller than those characterized by straggling scrub forms such as *Zizyphus lotus*. Thus the attempt to ignore human influence but emphasizes once again the fact that in regions of Mediterranean climate high forest appears to maintain itself with difficulty. If man's influence had been taken into account many of the forest areas marked on the map would have been so reduced as to have disappeared from a map on this scale. No indication is given on the map of the effects of the attempts at afforestation, and thus neither map nor text offers any contribution to the interesting problem of whether the decaying condition of Mediterranean forests is due in part to the fact that the number of species available for recolonization after the Ice Age changes of climate was much smaller than in Eastern Asia and Eastern North America, or whether present climatic conditions alone are responsible. It may, however, be noted

that to the visitor to Algeria to-day the woods formed of trees introduced from other parts of the globe seem a more conspicuous feature of the landscape in many places than those which figure in vivid tints on Dr. Maire's map.

The colouring of the map is somewhat crude, and the author has apparently found it impossible to carry out consistently any sort of "naturalistic" tinting. Thus, while green shades are used for the three oak formations, blues are used both for formations with conifers as dominants and for the mixed deciduous woods composed of elm, ash, etc., and there are other similar anomalies which make it difficult to grasp the map as a whole. But it is of course possible that this is intentional, and is intended as a hint that the scheme is purely theoretical and not an attempt to represent existing conditions. M. I. N.

REVIEWS

EUROPE

Cambridge Past and Present.— **Brian W. Downs.** Illustrated by **E. Vulliamy.** London: Methuen. 1926. 9 × 5¾, pp. vii. + 257. *Sixteen Illustrations in Colour.* 15*s. net.*

MR. DOWNS' book supplies several needs in reasonable compass. It is at once a history of the town, University, and colleges, a guide to the buildings of note and their contents, an introduction for the uninitiated to the customs and procedure of University life, and a commentary upon the latter, lively and humorous, which will appeal also to Cambridge men. In his treatment, which avoids becoming either tedious or scrappy, he has struck out a line which might well be followed by other "guides, philosophers, and friends," though they will not all achieve his success. As an introduction to Cambridge it would be difficult to improve upon this book, and its value is further heightened by the set of effective illustrations in colour.

The Place Names of Bedfordshire and Huntingdonshire.— **A. Mawer** and **F. M. Stenton.** (English Place-names Society, vol. 3.) Cambridge University Press. 1926. 9 × 6, pp. xlii. + 316. *Two Maps.* 18*s. net.*

This volume of the English Place-names Society equals in interest those previously published. Though the area covered has not a striking history, the work shows how a careful examination of the place-names, if it cannot bring out fresh facts, will corroborate results in other fields. The West Saxon conquest of the Ouse basin from the Middle Thames is placed at a comparatively late date: partly from the existence of an extensive and locally developed topographical term, "hoh," hill-spur. This late conquest may be accounted for by the former forests of the plains, for which there is evidence in the names. The theory of a British survival in the Fens receives no support. Interesting light is thrown upon the origin of the four names for the Roman roads: Icknield Way, Watling Street, Ermine Street, and Akeman Street. In all cases it is shown that these names were first applied to a limited portion and afterwards became used for the whole length of the road. Thus Watling Street is derived from the tribe of the Waclingas, the settlers on the site of Verulamium (Waclingaceastir). Similarly Ermine Street, with Armingford Hundred, derives from the ford across the Cam, known as Earningaford from the tribe of the Earningas.

Unknown Brighton.— **George Aitchison,** with Illustrations by **Stella Langdale.** London: John Lane. 1926. 7½ × 5, pp. xiv. + 166. *7s. 6d. net.*

Mr. Aitchison is right: too much is made of the Brighton of the Regency days to the exclusion of the shadowy far-off things and even of the picturesque, the mysterious, and the romantic things of to-day. He has set his text admirably in tune with the suggestive—if somewhat sombre—aquatints of the artist: "St. Paul's," "Little East Street," and the "Lanes" are, we think, the kind of subject she treats most effectively. The author writes very pleasantly, loves a good story, and can "write up" skilfully any odd little episode which has attracted him. The mere breath of rumour, a faulty etymology, a word or two with an archæologist will set him talking, and his discourse is in a light, whimsical vein. Like his illustrator, he is best when making romance out of the "Lanes," neglected by Erredge and Bishop, that part of Brighton which is the town's most picturesque and most distinctive heritage, its nucleus of artistic and historic interest. It is his merit that he opens up, or rather gives us a momentary peep into, many fresh vistas. It is refreshing to be reminded of prehistoric and Roman Brighton, of the Saxons landing on its beach, of French raids and Brighton pirates, of the devastating storm of 1703, and of the lost river which once meandered down the Steyne. It is to be hoped that many lovers of Brighton will sail with the author his "uncharted seas," even though the trip be of the "Skylark" order. S. E. W.

River Thames from Source to Mouth.— **F. V. Morley.** Illustrated by **Laurence Irving.** London: Methuen & Co. 1926. 9 × 6, pp. xi. + 255. *Sixteen Plates in Colour and Maps.* *16s. net.*

That the Thames for the greater part of its course flows through rural England, beyond the domains of industrialism, and that its valley was once a main artery of English life, are fortunate facts for the holiday-maker—they spell pleasant surroundings and rich memories of the past. And then there is the lively contrast of the life of the estuary. Mr. Morley has well utilized these circumstances. The greater part of his book consists of the literary associations of river and river-side towns, a wide field from which he has gathered lesser-known passages. His quotations are attractive and varied, and he makes the most of the opportunities, not limited to the more obvious ones presented by Oxford, Windsor, or London, for example. He also refrains from quoting Wordsworth or referring to Whistler. Into these literary and historic threads, he has woven a narrative of a voyage down the river in the "Wife of Bath," and a suggestion of a treasure hunt. The advantages of combining these elements into one book may be doubted, but at any rate there is something here for all tastes, without reckoning the sixteen pleasant water-colour sketches by Mr. Irving.

La Montagne Noire (Aude, Hérault et Tarn). Essai de Monographie Géographique.— **André David.** Préface de **Emm. de Martonne.** Dessins de **Léo David.** Carcassonne: L. Bonnafous. 1925. 10 × 7½, pp. 226. *Illustrations, Diagrams, and Sketch-maps.*

This pamphlet is the work of a brilliant young student of geography who lost his life in the war. The Montagne Noire, that south-western buttress of the Central Plateau which pushes out towards the plain, and marks the area of transition between Atlantic and Mediterranean France, was assigned to M. André David in 1913 as a special subject of study for his Diploma. He betook himself to his task with such fervour and success that when his material was presented he was urged to complete and elaborate it as a thesis for the

doctorate. The war made this impossible, and his family and friends have prepared his material for posthumous publication in order that the results of his labours should not be lost. The region is one of great interest, alike from the morphological and vegetational standpoints and from that of human geography. It retains certain primitive features, notably in regard to its local industries, of which a full historical account is given, while its agriculture is particularly interesting both because of the blending of crops characteristic of the Mediterranean and Oceanic climatic types respectively, and because of the changes which are taking place at the present time. All these aspects are treated fully and in careful detail, and the booklet will prove of great value to students of the regional geography of France. M. I. N.

A Cruise upon Wheels.— The chronicle of some autumn wanderings along the deserted post roads of France. **Charles Alston Collins.** With Illustrations by **Andrew Johnston.** London: Peter Davies, Ltd. 1926. $8\frac{1}{4} \times 5\frac{1}{4}$, pp. xi. + 484. *10s. 6d. net.*

This is a reprint of a work first published in 1862 by a son-in-law of Charles Dickens, in which a journey by cabriolet from Calais to Geneva is described. In the preface the author claims to have made a new discovery—the plan of writing "the history of a journey in which the interest attaches more to the persons who travel than to the places which they travel through." If this claim is justified, then this is the first of a very considerable species of travel book in which the reader is treated to facetious accounts of the doings of "fictitious characters" abroad. The author has been uniformly successful in avoiding dwelling too much upon the passing scene—he has not been, in his own words, to the Encyclopædia to "fish out half a hundred or so of ancient legends"—though a table of distances and expenses brings up the rear. Some readers, however, will find entertainment in this mildly Dickensian and long-winded account of the adventures of Mr. Fudge and Mr. Pinchbold.

ASIA

The Geology of the Netherlands East Indies. Lectures delivered as Exchange-Professor at the University of Michigan in 1921–22.— **H. Albert Brouwer.** Recorded and prepared by **L. M. Gould.** New York: The Macmillan Company. 1925. $9\frac{1}{2} \times 6$, pp. xii. + 160. *Eighteen Plates.* $3.

Notes on the Morphology and Tectonics of the North Coast of New Guinea.— **J. Zwierzycki.** *Philippine Jour. Sci.*, vol. **29**, No. 4 (Manilla, April 1926), pp. 505–513; 3 *Plates.*

The Eastern Archipelago as the link between Asia and Australia and containing the easternmost end of the fold mountains of the Alpine–Himalayan System is of special geographical interest. The literature of the Dutch East Indies is scattered, and Michigan University has earned the thanks of physical geographers by publishing Prof. Brouwer's brilliant summary of the evidence in his lectures as Exchange Professor. The volcanic and earthquake belt of the Dutch East Indies is especially instructive. Many of the volcanoes, according to Prof. Brouwer, were once larger and more powerful, as cauldrons have been formed by the collapse of volcanic cones. Some of the eruptions are of the Peléan type, and clouds of incandescent volcanic ash, which Prof. Brouwer describes as an emulsion of disintegrated volcanic material, have swept down the mountain sides. Earthquakes, which are frequent in the area, have only a secondary connection with volcanic action, and occur chiefly in areas of recent earth-movements. That the crust in the area has long been

subject to great vertical oscillations is shown by the deep-sea deposits in the islands belonging to many geological horizons. They resemble the well-known fossil oceanic deposits of Barbados, and they occur in the Trias, Jurassic, Cretaceous, and Pliocene. The western part of the area is a shallow platform from 40 to 45 metres deep, and Prof. Brouwer regards this "Sunda Shelf" as an old peneplain which has been submerged by a rise of sea-level due to the melting of the ice of the glacial period. This acceptance of Daly's theory contrasts with the account of the raised coral reefs which on the eastern islands occur at different levels and have been tilted, and show that at least the latest interchange between land and water was due to movements of the sea floor. Nansen's explanation of the coastal platform would appear adequate for the Sunda Shelf.

The shape of Celebes is attributed to fractures and vertical subsidences. Prof. Brouwer regards the eastern part of the Malayan arc as being still in process of folding and as moving horizontally at the same time. He regards this fold line as bent round like a crook at the western end, the Kei Islands being in the middle of the bend. It has been previously pointed out (*Geogr. Journ.*, July 1923, pp. 20–30) that the evidence for this crook-shaped fold is inadequate, as the known strikes of the rocks in the Kei Islands indicate, not pressure from the west, but that the islands are a residual arc left by the foundering of the Banda Deep. This view having been suggested before the date of Prof. Brouwer's lectures is not considered; the volume gives further support to it. Thus, instead of Buru, which is at the western end of the northern line, being overfolded from the south, it is overfolded from the north-east; Prof. Brouwer remarks that the Buru line carries on to New Guinea, and that the outside of the Timor–Ceram arc and the strike of the northern Moluccas are continued in Western New Guinea; he remarks, too, that the Kei Islands have a simple structure, whereas if they were part of a reflexed fold-mountain a complex structure would be expected. The Kei Islands moreover are not volcanic, whereas the part of the arc to the west with which they are correlated is the seat of recent volcanic activity. Prof. Brouwer's evidence shows that the view of Neumayr that the Eastern Archipelago was part of an ancient Sino–Australian continent and the later Equinoctia of Abendanon are both inconsistent with the evidence, as the whole region has been one of great and long-continued vertical earth-movements during which some parts of the area have been constantly occupied by the sea.

The little-known Dutch part of the northern coast of New Guinea has recently been investigated by J. Zwierzycki of the Mines Department of the Dutch East Indies, who has published a preliminary account of his observations. Along part of the coast raised coral reefs occur 60 metres above sea-level, while farther east they rise to from 300 to 450 metres. The author remarks that this high level is inexplicable, as there is no evidence of any such general submergence; possibly these higher reefs may consist of older coral limestones, or the uplifts may be local. The coral islands along the coast are thought to rest upon the summits of a sunken chain of mountains. The Kainozoic rocks include foraminiferal limestone and Globigerina marls which probably represent one of the deep-sea deposits known in other members of the Eastern Archipelago. Some active mud volcanoes are attributed by the author to the crushing of the rocks by compression due to earth-movements that are still in progress. The older crystalline rocks are regarded as relics of a ruined Pacific continent. The trend and texture of the mountains are similar to those of the Himalaya and the Alps, and the mountains

have been folded by pressure from south to north as in the Timor–Ceram arc, and that fact strengthens the connection of that arc with the mountains of north-western New Guinea. Probably some problems suggested by Mr. Zwierzycki's interesting preliminary paper will be solved by the promised fuller account of his observations. J. W. G.

A Book of South India.— **J. Chartres Molony, I.C.S.** (Retired). London: Methuen & Co., Ltd. 1926. 8½ × 5, pp. xii. + 252. *Sixteen Illustrations and a Map.* *7s. 6d. net.*

This is a pleasantly written account of life and work in the Madras Presidency by a recently retired civil servant endowed with humour and geniality: Mr. Molony describes with a facile and light pen his experiences in many parts of this, the senior, presidency, while performing that variety of administrative duties which to many is the charm of work in the I.C.S. We wander in the agreeable company of our author from among the highly intellectual races of the plains country to the wild environment of the Khonds, Mappillas, and Chenchus. We have a frank statement of the genesis of the last Mappilla outbreak; and we see the Chenchu still in a most primitive state—"idle, improvident, drunken, thievish, and brutal," as a public document described him in 1921. In most chapters brief notes of earlier historical events add interest to the narrative. The reader may realize from several of the anecdotes recorded (cf. pp. 36 and 96–97) how fundamentally the Oriental outlook often differs from our own, and how unsafe it is to apply Western criteria to Eastern problems. He will also acquire some conception of the extraordinary diversity of racial type and physical conditions met with in India. Appreciative character sketches have been inserted of some eminent Indians, and a well-deserved tribute paid to the splendid medical work being done by missionary and other organizations. C. E. A. W. O.

The Epic of Mount Everest.— **Sir Francis Younghusband, K.C.S.I., K.C.I.E.** London: Edward Arnold & Co. 1926. 8½ × 6, pp. 319. *Sketch-maps and Illustrations.* *7s. 6d. net.*

It is well that 'The Epic of Mount Everest' should have been put before the general public in a form more accessible than the substantial volumes which have furnished to mountaineers a detailed chronicle of the three assaults on the great peak. And the Mount Everest Committee are to be congratulated on having found at hand in their first Chairman, Sir Francis Younghusband, a bard exceptionally qualified both by his knowledge of the Himalaya and his enthusiasm for mountain exploration to do full justice not only to the dramatic incidents of the Great Adventure, but also to the spirit that prevailed among those who took part in it. While doing this he has been successful in bringing out the personal traits of many of the leading members of the three expeditions. In his pages we are quickly led to make friends with General Bruce, the jovial leader of the second party, to appreciate the mercurial grace of Mallory, the stalwart strength of Irvine, and the indomitable courage of Odell. We are told a simple tale of amazing endurance, daring, and unselfishness which deserves to be read by all Englishmen, and to be put in the hands of every English schoolboy.

It would have been easy for Sir Francis Younghusband to insist on the gain to physiology resulting from the climbers' experiences as to the capacity of the human frame to undertake strenuous exertion at heights over 24,000 feet. These experiences have effected a reversal of the opinion previously held by all but a few experts—among whom may be named that eminent

surgeon and mountaineer, the late Clinton Dent. Sir Francis might further have pointed out that, as the exploits of De Saussure marked the opening of the Alps to human uses, scientific and general, so the Mount Everest Expeditions indicate the way to further advances in travel and research in regions of the Himalaya less carefully preserved by native prejudices. He might have alleged additions to other branches of science to be drawn from the experiences of our intrepid explorers. But he has wisely wasted no space in combating the pretensions of those who demand of all adventure that it shall be justified by having a "serious scientific purpose." He prefers to look on the story he has to tell as another episode in the long struggle of the spirit of man to obtain mastery over the material forces of the world. He is content to ask his readers to assume that the thirst for discovery, one of the qualities that have gone to create the British Empire, is put to no unworthy use in exploring the secrets and revealing the hidden glories of the Poles or the Himalaya. He might well have taken for his motto the lines of Emerson quoted by an eminent scientist, Tyndall, in his account of the first ascent of the Weisshorn :

> "Men in these crags a fastness find
> To fight corruption of the mind,
> The insanity of towns to stem
> With simpleness for stratagem."

In a comparatively small volume Sir Francis Younghusband has been successful in weaving the events of the three campaigns against Mount Everest into a consecutive and engrossing narrative. He has framed the tragic story in a vivid description of the bleak Tibetan landscape and its secluded monasteries with their strange denizens.

To most readers of this *Journal* there will be no need to recall the incidents of the protracted struggle, the close approaches to success, the final catastrophe. But those who have in their time been mountain explorers beyond Europe may be invited by the opportunity afforded by the condensed narrative here put before them to consider what reflections for future use are to be gathered from its pages. Among the more important lessons for Himalayan explorers we should reckon these : that the climbers destined for a final assault *should come to it with powers unimpaired by previous exertions ;* that the staff of porters should be adequate to provision the two highest camps for at least four Europeans, and that one of the latter should be able to converse in Tibetan or Nepalese with their native followers ; that the final camp should be planted not necessarily higher, but nearer the summit than the Camp VI. of 1924 ; that if oxygen is to be used at all—and it would seem to be expedient that a small amount should be at hand to meet a case of emergency—the apparatus for carrying it must be both simplified and materially lightened ; that since a delay at start may make a vital difference in the day's accomplishment, and having regard to the tendency to slackness created by cold and altitude, very special effort should be made to avoid minor casual *contretemps*.

It can be hardly necessary to add that none of these suggestions are meant, or ought in any way to be taken, as criticisms on the conduct of the Mount Everest expeditions here recorded. Their leaders were hampered and handicapped throughout by a succession of grave pieces of ill luck. They had not to work out according to programme, but to do the best they could in the face of singularly untoward accidents and conditions. And yet they almost—possibly quite ?—succeeded in their object. They have proved that the highest mountain in the world can be climbed. Some year, when political barriers

are raised and the monsoon blows less incessantly, there will be a flag on the top of Mount Everest.

The volume is well illustrated, but the diagram on p. 62 is a poor substitute for the missing map. D. W. F.

Japan.— Rev. Walter Weston. London: A. & C. Black, Ltd. 1926. $8\frac{1}{2} \times 6$, pp. x. + 240. 32 *Illustrations in Colour and a Sketch-map.* 7*s.* 6*d. net.*

A new book by Mr. Walter Weston is sure of a welcome from Fellows of the Society, who know that he can both speak and write engagingly on Japan, of which he has had over thirty years' experience; and they know, too, that they can rely on Mr. Weston's words, whether written or spoken, being accompanied by a series of beautiful illustrations. In this latest book they will not be disappointed, and it may be regarded as a companion volume to the author's 'A Wayfarer in Unfamiliar Japan,' reviewed in the *Journal*, 67, p. 75. It is a book of sketches of modern Japan, and shows very clearly the changes that are taking place in the outlook of the people, and the results of their growing competition with the Western world.

Nowhere are these changes more apparent than among the women of modern Japan, and to this subject the author devotes special attention. Japan has always been a "man's country." It is, for example, only recently that women have been allowed the privilege of climbing Mount Fuji or any of the other sacred peaks. At about 5000 feet above sea-level an invisible belt was drawn, above which no woman was allowed to go. These objectionable restrictions were first broken down in 1867, when, for the first time in history, Fuji-san was climbed by a woman, in the person of Lady Parkes, wife of the British Minister. To-day, as Mr. Weston makes clear, the Japanese girl is no longer surrounded by significant reminders of the inborn unworthiness of her sex for many of the privileges of life. If she has not yet attained the status of her sisters in the West, she has at least made a good beginning, and there are many movements of the new age in which she is being allowed to compete with her men kind, and she may become a clerk, a typist, a teacher, a journalist, cinema actress, and even a doctor.

Mr. Weston also shows how the progressive spirit is affecting the manhood of Japan, even in the matter of sport and recreation. "Flower-viewing" is still the great national outdoor recreation, but baseball, golf, and ski-ing are becoming increasingly popular. So, to some extent, is skating, and it is a striking paradox (possible perhaps only in Japan) that the skaters should be able to bathe in the hot springs near by, or warm themselves, while resting, by lighting one of the natural jets of gas that are to be found on the banks of the lakes. O. R.

Japan in Silhouette.— Trowbridge Hall. New York: The Macmillan Co. 1925. $8\frac{1}{2} \times 5\frac{1}{4}$, pp. x. + 354. *Sketch-map and Illustrations.* 10*s.* 6*d. net.*

It is difficult to account for the publication of this book. The author has little to say that is fresh, and he contrives to bury it in a mass of verbiage that after a short time becomes exceedingly wearisome. In spite of the fact that a very large proportion of the volume is clearly made up of borrowed material, the writer seldom acknowledges his indebtedness to any of the sources of his information. The misstatements on many familiar matters of fact are so numerous as to render quotation difficult, though it may be permissible to specify such as the placing of the date of the Mongol invasion in the fourth century A.D., instead of in the thirteenth; and the naming of Kōbō Daishi as

founder of Buddhism in Japan, its introduction really taking place over 200 years before his time.

There is no index, but on the inside of the cover a clearly drawn map, which is unfortunately disfigured by many mis-spellings of important and familiar place-names. The most valuable chapter in the book is that which gives translations (the source not indicated) of some striking examples of modern Japanese popular literature. W. W.

AFRICA

Rambles in North Africa.— Albert Wilson, M.D. London: Jonathan Cape. [1926.] 9 × 6, pp. 296. *Illustrations.* 12*s.* 6*d. net.*

The basis of this rather discursive work is three recent visits to Algeria and Tunis, and its purpose is to enable others to follow the author into that newer field for tourists. Besides Algiers and Tunis, Constantine, Timgad, Biskra, Carthage, and Qairwan are among the places visited, and described in considerable detail. The author appears to have exercised some enterprise in getting away from the main centres. There is much detail on hotels and their staffs, length of journeys, conditions of travel, and so forth, which makes uninteresting, yet doubtless useful, reading. On wider, more general subjects, which one might expect to be treated, there is little direct information. The virtual avoidance of anything that could be called political may of course be deliberate, though the development of the country, progress of colonization, etc., might have been dwelt upon. The narratives of brief trips into the desert and of nights in the remoter towns testify however, indirectly, to the state of the country. The author also shows a desire to understand the life of the peoples encountered. The illustrations are numerous and of interest. The brief notes on geology and ethnology scarcely add to the value of the book.

Sport and Service in Africa.— Lieut.-Col. A. H. W. Haywood, C.M.A., D.S.O. London: Seeley, Service & Co., Ltd. 1926. 9 × 6, pp. 285. *Illustrations and Map.* 21*s. net.*

Col. Haywood began soldiering in the Niger Delta twenty years ago, when life was full of adventures for young officers of the West African Frontier Force. Many tribes were still fighting against administrative control, and political officers carried their lives in their hands. The military were frequently called upon to help the administration, and the occasional murders of white men led to arduous punitive patrols. The author's account of his early years on the coast is full of interest.

After a period of service in England he was posted to Sierra Leone, where life was less eventful than in Southern Nigeria. It afforded, however, an opportunity for a shooting trip in the French Sudan, followed by an enterprising journey across the Sahara to Algeria. The author has given us in another volume a detailed account of this journey, but he recounts many of its incidents in his latest book. He returned again to Southern Nigeria, and on the outbreak of the Great War he was given command of one of the columns which invaded the Cameroons. His reminiscences of the campaign include one of the many brilliant exploits of that very gallant and much-decorated "Waff," Sergeant-Major Belo Akure.

At the end of 1916, when the Allies were gravely concerned over the shortage of man power, Col. Haywood was sent out to report on the recruiting fields of the West African colonies. Although the intensity of the German submarine campaign prevented full use being made of its resources, British West Africa's

contribution amounted to 70,000 men. In 1920 Col. Haywood was appointed Inspector-General of the West African Frontier Force, which he had joined as a subaltern in 1903. His annual tours of inspection gave him increased facilities for big-game shooting, a sport to which much of his book is devoted. The country is not usually regarded as very attractive to sportsmen, but the author has shown that, given the necessary enthusiasm and energy, most trophies may be obtained in West Africa.

During his travels Col. Haywood collected a good deal of miscellaneous information, but it is to be regretted that he has not taken more trouble to verify the statements he repeats. His historical information is particularly unreliable. The date of the Moorish invasion of Songhai was 1591, and not 1482, and Sir John Glover was not Governor of Lagos during the voyage of the *Dayspring*, but a junior naval officer in charge of the survey work of the expedition. Nor is Carthage a felicitous example of a lost desert city buried in sand. But the book is not intended for the student, and the general reader may be depended upon to forgive when there is so much to amuse and interest him. He must be prepared, however, to endure with his usual patience constant irritation from a most inadequate map. E. W. B.

The Peoples of Southern Nigeria.— P. Amaury Talbot. 4 vols. Oxford: University Press. 1926. 9 × 6, vols. **1**, pp. 365; **2** and **3**, 976; **4**, 234. *Maps and Illustrations.* £3 10*s. net.*

The slowly growing library of literature on Nigeria has been enriched by the publication of this voluminous book. Undertaken in connection with the 1921 Census of population in the southern part of the Protectorate, the task of collecting the information afforded to the reader reveals an immense amount of labour both in research and arrangement. The result is praiseworthy. To one like the reviewer, possessed of many years' experience of the tribes in the Northern Provinces of Nigeria, but of a merely general knowledge of those in the south, the book has conveyed a clearer picture of the mass of tribes along the coast and its nearer hinterland than he has found in any other which he has read.

To hint that there may be some inaccuracies both in the historical and the statistical details should in no way detract from the recognized value of this first effort to attack the subject comprehensively. The task was a big one, and unfortunately for the moment has lacked the scientific help of anthropometry. Mr. Talbot himself remarks in his foreword that the chief work—the classification of tribes and definition of their boundaries—has had to depend almost entirely on the basis of language—a basis which some will think not the most reliable, but the results of some thousands of his personal measurements, which are promised later, will test the correctness of his conclusions.

Out of the mist of earliest times the author has drawn the outlines of the migration of Negro tribes to the whole of Western Africa, and in some seventy pages gives us a general history of Nigeria as a whole from the second millennium B.C. to the present time, tracing foreign influences, the advent of Portuguese and English traders, and the gradual development of the country. The rest of the first volume is devoted in more detail to an account of the peoples as now inhabiting the twelve provincial areas of Southern Nigeria, in which account he disentangles the original threads from about the fourteenth and fifteenth centuries, and shows the various settlements in the different areas. The story of the Yorubas, the Egbas, the peoples of Benin and Calabar is full of interest. Strange weird figures flit across the stage: the Awni of Ife, believed by the

Portuguese to be the legendary Prester John, the mighty Obba of Benin, and the curious kings of the delta tribes. Much, too, is told of the first ventures of Europeans into the coast belt, and of the conditions which they found there.

For the purposes of his ethnological survey the author has divided the population into three main groups: the Sudanese (for want of a better term), the Semi-Bantu, and the Bantu. The most ancient tribe would seem to be the Ijaw of the Sudanese group, who were descendants perhaps of the earliest Negroes who ever penetrated the West African forests. Generally speaking, the Sudanese group (comprising also the Yoruba, the Edo-speaking people, and the Ibo) occupy the west and central portions of the country, and the Semi-Bantu group, of which the Ibibio are most numerous, the east. The Bantu—numerically small—inhabit the south-east corner. When it is remembered that these three groups contain in all some thirty tribes, split up into more than one hundred sub-tribes, and again into two hundred clans or more, one can get some idea of the difficulties encountered in classifying these people on a language basis alone.

There are many maps and tables of distribution showing religious beliefs, influence of witchcraft, types of government, twin-birth tabu, etc.—all useful as data for classification—and the second and third volumes cover a great deal of ground relating to these subjects and to customs of birth, marriage, and death, together with the laws of crime, tabu, inheritance, and slavery.

The chapters on the religion of the tribes, described as being compounded of polytheism, anthropomorphism, animism, and ancestor worship, and the general connection of Nigerian cults with those of ancient Egypt and the Mediterranean area are very interesting, and tend to show how great an effect the Negroes—an intensely religious and spiritually sensitive race—had upon the northern beliefs. Not less interesting is the account of the minor deities, or Ju-jus—our word derived from the French Jou-jou—the symbolic dolls or images which represent the spirits. Mr. Talbot's own words are worth quoting in this connection: "These spirits form the main support of the Negroes' laws and customs—the policeman who detects wrongdoing as well as the judge who punishes it." In the main the spirits would seem to be benevolent or at least neutral, although their functions often are to award punishment or bring retribution upon evil-doers.

These volumes, then, are eminently readable and informative, and are profusely illustrated with excellent photographs. Altogether they mark a distinct advance in our knowledge of West African native races. A. C. G. H.

With the Riff Kabyles.— Bernd Terhorst. London: Arrowsmith. 1926. 9 × 6, pp. 238. *Illustrations.* 12*s.* 6*d. net.*

The Fire of Desert Folk. The account of a journey through Morocco.— F. Ossendowski. English text by **L. S. Palen.**. London: G. Allen & Unwin, Ltd. 9 × 6, pp. 312. *Sketch-map and Illustrations.* 16*s. net.*

The first of these two books dealing with the Maghreb is a very slight collection of articles on the territory formerly under dispute between the Spaniards and Abd el Krim. The author has evidently not had very much experience of the East. In the process of absorbing local atmosphere, of which he has a nice appreciation, he has swallowed some pretty "tall" stories. The book is well produced and very readable. The drawings are a pleasant relief from the conventional photographs which usually accompany this type of volume.

Dr. Ossendowski's book is a more interesting contribution. He made a

journey in Algeria and Morocco of a, by now, somewhat conventional sort. The French authorities did well by him. In showing him all the sights, they showed off their work in North Africa to the best advantage. The author was however too shrewd an observer to be taken in by their rather obvious propaganda, be it never so justified. In some respects the book is a valuable commentary upon the controversy which has arisen on the subject of his Asiatic wanderings. It throws considerable light upon the acumen of the author and his capacity for local observation and deduction. The major problems attending European administration of an Eastern land with all its ancient philosophy are never far from Dr. Ossendowski's thoughts, whatever he may be writing about. For some tastes there may be too much description and telling of picturesque stories, but the vital issues are always remembered and are well postulated. His speculations are made without "romancing." Apart from the political problems, the author has had occasion to wonder a good deal about the popularly accepted racial unity of the Berbers. These doubts, in the face of conventionally accepted dogmas, do credit to a new-comer in North Africa; they are proof, if it be needed, of Dr. Ossendowski's competence as a scientific traveller. If his story is well told, in this book at least it is also good material.

One cannot but regret the spelling of many Arabic names and words. These lapses are the more unfortunate by virtue of the author's reference at the head of his glossary (which itself is far from faultless) to the value of the R.G.S. Committee's work on Proper Names. The photographs are good, but the reproduction does not do them justice. F. R. R.

AUSTRALASIA AND PACIFIC ISLANDS

Byways of the Tropic Seas. Wanderings among the Solomons and in the Malay Archipelago.— Herman Norden. London: H. F. & G. Witherby. 1926. Pp. 250. 63 *Illustrations and* 2 *Maps*. 16*s. net.*

The reputed charm of Bali, "that fragment of land broken off the eastern end of Java," captured Mr. Herman Norden's imagination, and he determined to visit it. But when his plans were made, he tells us, he heard a lecture on the Solomon Islands at the Explorers' Club in New York, and found he wished to see the terrible Solomon islanders almost as much as the beautiful Balinese. So he determined to go to Bali by way of the Solomons, although such a journey involved several thousand miles of extra travel and was something like going "to Glastonbury by way of Goodwin Sands," as Mr. Chesterton has it. When he reached Tulagi, the capital of the British protectorate in the Solomons, he chartered the ketch *Ugi*, in the company of whose owner, Bobby Stirling (trader, planter, and recruiter), he was able to visit Malaita, which island is, in parts at least, still as savage as when Mendaña first sighted it in 1568. Half the book is devoted to this cruise: it is a personal narrative, and though it adds little to our knowledge of the Solomons, Mr. Norden writes with considerable charm and humour of his experiences and of the people he met, both white and black.

The second half of the book makes a good contrast. Malaita was grim, its people savage and grotesque; in Bali Mr. Norden found a lovely land, a beautiful people, with culture, temples, and religious ceremonies that were a strange mixture of primitive and of highly developed faiths. Mr. Norden has the quick eye of the experienced traveller for essentials, and he knows how to keep his reader interested. The result is a very readable book which does reproduce the colour and atmosphere of those tropic islands.

The book is well illustrated and the sketch-maps showing Bali and the Solomons are useful, but the index is deplorable. An index to a book of this kind must be detailed, if it is to have any value for reference purposes. But here we find under the entry " Bali " forty-six references merely to the numbers of pages, while " Malaita " and " Solomon Islands " have thirty-three each, without any subheadings at all, so that any one who is in quest of a reference might search page after page before finding what he wants. O. R.

Western Tasmania. A land of riches and beauty.— Charles Witham. Hobart : Mount Lyell Tourist Association. 1924. $8\frac{1}{2} \times 5\frac{1}{2}$, pp. vii. + 168. *Illustrations and Map.*

This handbook gives a detailed description of Western Tasmania and its history, with much information not easily to be found elsewhere. The writer's interests are mainly in the mountains, the beauty of their scenery, and the chances they offer to the lover of nature; consequently he is not altogether disturbed that nine-tenths of the area is uninhabited, that the population is declining, that roads are few. Yet he is writing an account of the whole, and thus there is a full account of the mining industry, of the varied output of metals, including gold, silver, tin, lead, and copper, and the prospects for the future. He also includes a detailed account of the early exploration and the convict station in Macquarie harbour. All these varied aspects are bound together by the obvious enthusiasm of the writer for his subject.

MATHEMATICAL AND PHYSICAL GEOGRAPHY

An Introduction to Earth History.— Hervey Woodburn Shimer, Professor of Palæontology in the Massachusetts Institute of Technology. London : Ginn & Company. $8\frac{1}{4} \times 5\frac{1}{2}$, pp. vi. + 411. 141 *Illustrations.* 12*s.* 6*d. net.*

We read in the Preface that " The volume is planned to serve as a point of view, a general survey to introduce the student to the more detailed knowledge of the earth than can be gained through chemistry, physics, astronomy, geology, and biology." This rather ambitious programme naturally lays itself open to the objection that applies to all books of a similar nature and size—that it can give only a condensed and rather dogmatic treatment of the matters discussed.

The volume is divided into three parts, dealing in turn with The Cosmical History of the Earth, The Geological History of the Earth, and The History of Life upon the Earth. Each of these in turn deals with matters which can hardly be discussed adequately in one volume, so that while the author has certainly succeeded in making the chapters interesting, they are very sketchy and broad generalizations are made. It is doubtful if the " student " referred to in the Preface would gain very much by a perusal of the work, since the rather vague descriptions would hardly enable him to picture the features described. For example, on p. 76 we read, " When surface melting renders the glacier too light to be able to continue pushing the load beneath it, it rides up over the dropped material, elongating it in the direction of movement of the glacier. These deposits, thus modified into drumlins, correspond to the sand-bars in a stream." Is this a clear description of a drumlin ? Again, the dozen lines devoted to Lead and Zinc in the chapter on " Geologic Products of Economic Use " are entirely inadequate.

However, while it is easy to write a distinctive criticism of such a volume as this, there is another point of view. A general summary of the many trends of modern geological thought is useful in focussing attention on the, pre-

sumably, ultimate aim of that science—a complete account of the History of the Earth. In an age of excessive specialization the general reader may be excused for wondering where the specialists are leading. Professor Shimer has, to some extent, coordinated these trends, but we cannot help feeling that he might have done so in a more useful way.

The illustrations in the book are good. J. A. S.

HUMAN AND HISTORICAL GEOGRAPHY

Geographie des Welthandels : Eine Wirtschaftsgeographische Erdbeschreibung.— Franz Heiderich, Hermann Leiter, and **Robert Sieger.** Vol. 1, Europe. Vienna : L. W. Seidel & Sohn. 1926. 10 × 7, pp. xx. + 1178. *Eleven Maps.* 42*s. net.*

Allgemeine und Spezielle Wirtschaftsgeographie.— Dr. Ernst Friedrich. Vol. 1, Allgemeine Wirtschaftsgeographie. Berlin and Leipzig : Walter de Gruyter & Co. 1926. 9 × 6, pp. viii. + 249. GM.12.

We are indebted to Germany for two noteworthy contributions to economic geography this year, in the form of new and completely revised editions of pre-War publications.

One is a new edition of Andrée's ' Geographie des Welthandels,' a formidable tome of 1178 pages, and the other is a theory of Economic Geography by Dr. Ernst Friedrich, Professor of Leipzig University.

Karl Andrée's ' Geographie des Welthandels,' first published during the years 1869–72, was entirely re-written by Professor Heiderich, of the Hochschule für Welthandel, Vienna, and Professor Sieger of Graz University, and the first three volumes were published in 1910–13. The war has made necessary another edition, the first volume of which lies before us, and the editors who have this time enlisted the aid of Professor Hermann Leiter of the Vienna School of Commerce, are to be congratulated on having brought this ponderous volume up to date so rapidly and so efficiently. It requires much energy and courage to publish a work of this sort during a period of economic and political restlessness such as we are passing through, when the information toilsomely collected one day may be out of date the next. We suggest, incidentally, that the publishers may find it expedient to publish annually a set of revisionary notes and comments, which we feel sure would be welcomed by students of economic geography the world over.

The editors have provided a general plan for the various sections of the book, but the authors have been allowed considerable latitude.

The plan of each section is, generally, as follows :

(1) The physical basis of the economic geography including a study of position and boundaries, soil and minerals, climate and vegetation, population and settlement.

(2) A section describing the various regions.

(3) An account of industries, trade, and commerce.

(4) A summing up of the economic position of the country under discussion.

(5) A bibliography.

The longest sections are those on Germany and Russia. Oberst Friedrich Immanuel of Marburg A. Lahn treats his subject, Russia, from the historical and political point of view, and gives but little space to a description of physical conditions. Sixteen pages are devoted to a study of races, religions, nationalities, settlements, and migrations of the people. The study ends with a critical survey of Lenin's ambitions and accomplishments, and a short summary of the political situation. It makes very interesting reading, but one is left wondering how much of it is geography.

Professor Eric Obst of Hanover presents another study which departs somewhat from the general order of the book. He is concerned rather with giving an account of the industrial and commercial situation of Great Britain at the present time than with writing an economic geography of our country. The conclusions he comes to are not encouraging from the British point of view. Indeed, his contribution is something in the nature of an *oraison funèbre!* "Dark and uncertain is the future," he pronounces with, one cannot help feeling, a certain gloomy glee! He bases his "pessimism" on a comparison of 1923 with 1913 trade figures, backed by quotations from Norman Angell; but what he fails to remark is that, as the Committee of Industry and Trade point out in their Survey of Overseas Markets (published 1925), gloomy as the outlook may be, our position in relation to world trade as a whole was better in 1923 than in 1913. In other words, we are all in the same boat, much battered in the War, but Britain had as good a position in 1923, if not a better one, in that boat, than she had before 1914. The Professor pays much attention to Ireland, to the significance to Britain of the Celtic and Roman Catholic fringe, and especially to the revival of the Celtic tongues. "Those who wish to do business with Ireland now," he says, "will hardly be able to make shift without a knowledge of Erse"! Who knows, if the Germans, in the course of their development of the Irish Free State, through the Siemens-Schuckert Shannon and subsequent schemes, equip themselves with a knowledge of Irish, but that they may teach it, with their usual systematic thoroughness, to the Irish themselves? The author prophesies that a spread of the Gaelic language and Home Rule for Scotland will follow very shortly.

The section on France by Professor Vogel of Berlin is perhaps the most complete of these studies. Excellent use has been made of the numerous French monographs and descriptive articles that have appeared in French geographical journals from time to time, and the compressed regional studies of the major "pays" of France are admirably clear and withal picturesque. Throughout, the relation between the physical and economic geography is kept well in view. Full importance is given to the post-War development of France as a metallurgical country, and also to the resulting economic problems that face her, of which not the least serious is that of the ever-increasing foreign element in the ranks of her labour.

It is impossible to review a joint composition of these dimensions in detail; but perhaps enough has been said to give an idea of the scheme of the book. We will content ourselves with adding that the work is done, on the whole, in a very thorough and competent manner, and that the short summary of the present economic position and future outlook of the country with which each section terminates, generally gives evidence of thoughtful and fair-minded study, and in any case is interesting to the English reader as providing an authoritative German point of view.

Volume **2** of Professor Friedrich's 'Allgemeine und Spezielle Wirtschaftsgeographie' deals first with the function of Economic Geography and the study of the factors concerned in economics and their geographical distribution: latitude and climate, land and water, plants and animals; then with Man as an economic being, involving some fifty pages of rather dreary classification which does not appear to get one much further; and, finally, with a study of plant, animal, and mineral economics, industry, commerce, and transport. The work is very thorough in the sense that it is difficult to find anything that could possibly come under the head of economic geography that does not receive at least a mention. This means, of course, that in 228 pages no subject

can be dealt with really thoroughly. Generally speaking, the book consists of a careful arranging and classification of common knowledge rather than a study resulting in fresh ideas. Nevertheless, it does include new and important matter, and the shrewd, critical observations of the author show a keen sense of values in practical matters and augur well for the practical volumes which are to follow. H. O.

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EUROPE

Early County Maps.

SINCE the article by the Librarian on this subject appeared in the *Journal* for October 1926 a few additional facts have been brought to light, which may here be noted by way of appendix. It has now been possible to examine the MS. maps by William Smith, to which brief reference was made in the article, when the possibilities of authorship of the anonymous series of *circa* 1602–03 were being discussed. Two of these, of Lancashire and Cheshire, are preserved in the MS. Department of the British Museum, while copies of the Cheshire are also to be found in the Bodleian at Oxford. The Lancashire (Harl. MSS. 6159, f. 2) is dated 1598 and signed W. S. R., *i.e.* William Smith Rouge Dragon, and there is no doubt of its original character, the paper being of the period in question. A comparison of this map with the map of Lancashire in the anonymous series shows at once a virtual identity, both as regards the outlines and the place-names. There is agreement both in the choice and in the spelling of the names, where these show divergences from Saxton's original. In both, for example, we find the spelling Rachdale for Rochdale, and on turning to Smith's 'Description of England' (p. 47, as printed in 1879) we read of "Rochdale (comonly called Ratchdale)." The scale too is almost the same (though slightly smaller in the printed map), and in both the north is to the right. The agreement between Smith's MS of Cheshire and the corresponding map in the printed set is not so close, the MS version being in particular a good deal smaller. The British Museum copy (Harl. MS. 1046, f.), though dated 1585, proves to be a later copy, for it is in a MS volume written on the same paper throughout, in which dates as late as 1623 appear, while the style of the watermark seems to point to a later decade still. The Bodleian specimen (Rawl. MS. B 282, f. 18), of which a photostat copy has been obtained through the courteous permission of the Librarian, is very like that in the British Museum, and both show close agreement with the printed map in the courses of the rivers, etc., and the unusual spelling of some of the names (Maxfeld for Macclesfield, Stopford for Stockport, may be instanced) in which we find agreement too with Smith's 'Description of England.' It therefore seems obvious that some connection existed between Smith and the anonymous printed maps of these two counties.

A clue to the engraving of one at least of the maps—Leicestershire—has been supplied by a correspondent, Mr. S. A. H. Burne of Cheadle, Staffs., who points out that William Burton in his 'Description of Leicestershire' (1622) refers to an improved map of the county in 1602 as due to himself and Hondius jointly. The passage in question occurs in the preface "To the Reader," an extract from which has been kindly sent by Mr. E. W. Lynam of the British Museum. It runs: "As for the Topography of this Countie, at the request of a friend of mine I rectified (certain yeres passed, Christopher

Saxtons mappe of this Countie) with an addition of 80 townes, which was graven at Amsterdam by Jodocus Hondius 1602, and since imitated by M. Speed in his great History of Brittaine, with an augmentation of the plot of the towne of Leicester, and reduced into a lesser forme and here inserted. . . ." (The reduced map in Burton's book is merely a reprint, from the same plate and with practically no change, of that engraved by Kip after Saxton for Camden's Britannia.) It does not necessarily follow from the above that the Leicestershire did not form one of the series, for the " friend " spoken of by Burton may have been interested in the whole set of maps. It may even be that he was William Smith. It is interesting to find the definite statement that the 1602 map had been copied by Speed.

A slight inaccuracy in the original article may be here corrected. The English Ortelius of 1606 was spoken of as brought out by Vrints at Antwerp. It was in fact published in London by John Norton, but the plates were certainly supplied by Vrints, and the use of the same paper as for Vrints' own issue of 1603 seems a reason for supposing that the maps at least were printed at Antwerp, and then sent over to have the English text added on their backs.

The Situation of Clermont-Ferrand.

One of the striking and suggestive studies at which French geographers excel is devoted by Mons. P. Arbos (*Rev. Geogr. Alpine, Grenoble*, **13**, 1925, fasc. 3) to a consideration of the situation of Clermont-Ferrand and its effect on the history of the town. The Limagne plain, with which it is closely associated, runs north and south and is shut in both east and west by crystalline massifs, that to the west being reinforced by volcanic outpourings. Its *entourage* may be considered both as a region of contact and one of passage—contact as affording facilities for intercourse with neighbouring districts of widely differing characters, and passage as the crossing-point of routes between distant countries. The plain—level and inclined to be marshy to the north, strewn with volcanic elevations to the south—is everywhere of marked fertility, producing abundant crops of corn and fruit, while the lower slopes of the hills support vineyards, particularly on the west, where they find shelter from the strong winds. The mountains on either side produce timber and pasturage for flocks and herds, and both plains and mountains supply excellent building stone. Human settlements therefore found in this region all the elements of prosperity in the exchange of these various products. The district is fortunate, too, as the meeting ground of lines of more general circulation, for while offering the one decided break in the Central Massif from north to south, its east and west barriers are more easily surmounted here than in other parts, and it is through Clermont-Ferrand that relations have been established between Lyon and Bordeaux, as well as between Northern and Southern France. Here, too, the passage of the rivers has been easier than elsewhere, and from the twelfth century on the Pont du Château over the Allier was the one and only passage of that river for a very long distance. On the other hand, the central situation of Auvergne, far removed from all ports or national frontiers, has been a drawback, and the poor facilities for navigation offered by the Allier have been another. A rich region like that under discussion was anyhow bound to attract human settlement, and suitable sites are plentiful, whether on the hills to the south, the banks of the Allier, or the western border of the Limagne, where the volcanic outpourings from the Dômes have offered special advantages through the water-supply issuing along the zone of contact with the underlying impervious strata. Clermont-Ferrand did not however take its present assured place as capital

of Auvergne without the competition of rivals, and the last section of the paper is devoted to a discussion of the reasons for its triumph over the ancient capital of Gergovia. The latter's importance in the time of Cæsar's wars was due to its unequalled facilities for defence; and when Cæsar finally defeated Vercingetorix and imposed the *Pax Romana*, such considerations were of less importance, and were even directly unfavourable to commercial development. Nemossos was in every way more suited to men of peace, and its choice by the Romans to replace Gergovia gave it, besides, the further advantage of a political and administrative centre.

ASIA

The Hai-ninh District, Tongking.

A detailed study of Hai-ninh, a portion of Tongking between the Red River and the Chinese frontier, is contributed by M. E. Chassigneux to *La Géographie*, August 1926. Without easy communication with the Hanoi delta, from some points of view it may be regarded as a south-west extension of Kwangtung, to which the coastal plain gives access. A feature of its morphology is the parallel direction of islands, coast-line, mountain ranges, and valleys, all trending from south-west to north-east. Four geological zones are distinguished in the mountain region. Behind the alluvial plains are low hills of red sandstone, succeeded in turn by old schists and more resistant conglomerates. In the interior is the bold granite massif, with a sparse vegetation covering, and cut by deep ravines, which gives place on the west to the even more eroded triassic formations. The distinct erosion forms of each of these areas are described in detail. Hydrographically, the rivers form a consequent system, cutting across the formations to the coast. They are in a state of immaturity, with steep profiles and many falls. So deeply have they cut into the alluvial plains that the heavy seasonal rainfall is carried off without flooding.

The coastal plain has some unusual characteristics. The river courses are marked by small rapids almost down to their mouths. Behind the islands they have built up deltas, which, with mangrove swamps are gaining rapidly on the sea. These and other facts point to a recent slight rise in the level of the land, which has rejuvenated the drainage system. This is particularly evident in the delta of the Song Ca-long. Its mouth is more exposed to tides and currents, under the action of which a long sandy spit of about 14 km. has formed, resting upon a rocky island to the south, and separated from the rest of the delta by an arm of the sea, where deposition is taking place. In the upper part of the delta, traversed by two branches in deeply cut beds, erosion and not deposition is taking place. On the original surface of the delta are abandoned branches of the river, with some small recently developed obsequent streams. The paper also deals in detail with the character and distribution of the population. One feature is the advance into this frontier transitional region of Chinese immigrants at the expense of the Anamese, an advance which the author would like to see checked by the Government.

AFRICA

The 1/Two Million Map of Africa.

The Acting Surveyor-General of Egypt calls attention to an error in Sir Charles Close's article in the *Journal* for September last, page 255. Speaking of the 1/2,000,000 map of Africa he said that the Geographical Section, General Staff had completed no fewer than eighteen sheets, the French had published three provisional sheets, and the Survey of Egypt one.

The Acting Surveyor-General asks us to state that the Survey of Egypt has not published any sheet of this series. Reference to the Sudan sheet in question shows that it was compiled and drawn for the War Office by the Sudan Survey Department, Khartoum, 1920–21, was printed by the Survey of Egypt in 1922, and was published by the Geographical Section, General Staff. Although therefore the sheet is included in the block which was assigned to the Survey of Egypt it was not published by them, though their name appears as printing it.

The Kalahari Reconnaissance of 1925.

In 1925 a reconnaissance party, organized by the South African Dept. of Irrigation, visited the area between the Zambezi and Lake Ngami to collect facts upon which the further discussion of the " Kalahari redemption scheme " might be based. The Report has now been issued by the Department (Report of the Kalahari Reconnaissance of 1925. Pretoria, 1926). With this scheme the name of Dr. E. H. L. Schwarz has been identified, and at his request he was allowed to accompany the party, the leader of which was Dr. A. L. du Toit. Dr. Schwarz has already described in the *Journal* (**67**, 528–35) a journey he subsequently made to Lake Ngami and the Botletle River. The work was to be particularly devoted to obtaining details on levels, river discharges, meteorological and geological features, and the area was to be surveyed. Two aeroplanes accompanied the party, and air photographs were made of the Zambesi from the Victoria Falls to Katima Molilo, and of portions of the Linyanti (Kwando), Makwegana, and other rivers. A map on the scale of 1/500,000 accompanies the report. The method generally adopted was to combine compass and stadia reading with levelling operations, the traverses thus obtained being controlled by eight astronomically determined positions. Time signals were received from Lorenço Marques and Slangkop. The total distance over which levelling was carried out was 730 miles. Appendices to the Report also give notes on the discharge of the Zambesi, analyses of soil from the Kalahari, and meteorological observations. The body of the Report, however, deals mainly with the hydrography of the area from the point of view of irrigation schemes both on the scale proposed by Dr. Schwarz and of lesser magnitude. As is acknowledged in the report, some of the material utilized here has been obtained from other sources; the party did not examine the Okavango or the Botletle rivers, and much research remains to be done in this area. Without entering into details, the final conclusions of the reconnaissance may be summarized here. The existence of a " Greater Ngami," which has since disappeared through desiccation, is denied. No lacustrine deposits were observed in the neighbourhood, and it is suggested that the Makarikari depression has been deprived of its water-supply by faulting and sinking probably connected with the East African Rift Valley. It might be possible to canalize the lower Okavango and lead the water into the Makarikari depression, though it is likely that this would simply remove the area of swamp from the one place to the other. The only method of obtaining water for irrigation purposes on a large scale would be by damming the Zambesi at Katombora and diverting the water into the Mababe depression. After provision for maintaining the Victoria Falls, one-tenth of the Zambesi's discharge, at the expense of two-fifths of the flow, could be diverted in this direction.

AMERICA

Forest Resources of Canada.

The present condition and prospects of the forest industries of Canada are fully described by Mr. R. D. Craig of the Dominion Forest Service, in *Economic Geography*, July 1926. Second in importance only to agriculture, their products comprise 23 per cent. of Canada's exports, the value of the paper and pulp produced annually being 182, of lumber 126, and other items 57 million dollars respectively. It is stated that 13 per cent. of the total land area is under exploitable timber, but that one-half of this is still inaccessible. On a physical and climatic basis, Canada is divided into three forest regions: the Cordilleran, the Great Plains, and the Eastern. Similar factors produce the various belts within each of these. Thus the Cordilleran timber ranges from the Douglas fir—red cedar type of the south coastal belt to the Lodgepole pines growing up to 7000 feet on the Rockies. The main area in the Great Plains, the Northern Forest belt 300 to 400 miles wide, lies between the prairie belt, thought to have been mainly cleared by fire, and the Sub-Arctic region. Here the white spruce predominates. This belt extends into Eastern Canada north of the St. Lawrence–Hudson Bay divide, where, through bad drainage, the black spruce tends to predominate. South of this, beyond the transition belt, from Lake Superior to the mouth of the Saguenayr, lies the mixed Hardwood-Softwood type, the white pine area, which has been most exploited for lumber.

Similar influences have controlled the methods of lumbering. In the hard winters of the east and the Great Plains the timber is cut and logged by sleighs to the rivers for the spring thaw; in British Columbia the problem is an all-the-year-round engineering one, and the logs are hauled by cable and railways to the water or to the mills. The annual cut is approximately 2500 million cubic feet; of this 822 million are used by the lumber industry, and 362 million for pulp and paper. Of the 3000 saw mills, most are in Quebec, but the best are in British Columbia, where, unlike Eastern Canada, the industry is growing. The total annual output of lumber (1919–23) was $130 million, of which Eastern Provinces produced $80 million and British Columbia $46 million. In the paper and pulp industry however Quebec leads the way, producing $76 million, as against 61 by Ontario and 15 by British Columbia. In the export trade the outstanding fact is the predominance of the United States, the receiver of 82 per cent. of Canada's forest exports. It is said that two-thirds of the newsprint used there originates in Canada. As to the future, Mr. Craig considers that fires have caused the greatest damage to the original timber stand. Up to the present 60 per cent. of this has been lost in clearing and by fires, and only 13 per cent. by use. Thus if forest fires could be prevented and logging improved to favour reforestation, he thinks present output could be maintained.

Seismological Work in the United States.

The *Bulletin* of the Seismological Society of America for September 1926 contains two or three items of interest. Mr. R. H. Tucker discusses carefully the possibilities of ascertaining changes of position of portions of the crust due to earthquakes by triangulation measurements. The results of determinations of position at different epochs for various stations in California on either side of the San Andreas fault are tabulated, with the result that the averages of the residuals seem to be larger than should be due to the probable errors in the triangulations. The four epochs dealt with are 1855, 1885, 1907, and 1922, and it is found that the average residuals are much alike at all,

close to 3 feet, while those at mean distances of 3 miles from the fault are not sensibly larger than those at 18 miles. The conclusion is reached that when the systematic errors at each epoch are combined with the accidental errors of triangulation, the residuals may not greatly exceed the sum. Between 1885 and 1907, however, the period which included the great earthquake of 1906, the figure for the displacement is convincing even at average distances of 11 miles from the fault. In another paper Mr. N. H. Heck discusses and maps the distribution of earthquake epicentres in the North Pacific, showing their association in general with deep submarine troughs. Near the supposed Aleutian trough however the epicentres are widely scattered, and it is held to be very desirable that an accurate survey of the bottom of this part of the ocean should be made. In a paper on the Jesuit seismographic stations in the United States and Canada, the Rev. J. B. Macelwane, S.J., points out that the interest in seismology displayed by Jesuit institutions in recent years has been due to the initiative of one man, the Rev. F. L. Odenbach, S.J., who in 1909 addressed a letter to all the Jesuit Colleges and Universities in the States and Canada, with the result that instruments were installed at eighteen different stations, and regular observations kept up for some time. But interest subsequently flagged, until latterly only two stations in the United States were still publishing earthquake data. In 1925, however, as a result of a conference at Chicago, a new Jesuit Seismological Association was formed, and it is hoped that good results will follow if sufficient funds are forthcoming.

MATHEMATICAL AND PHYSICAL GEOGRAPHY

Tropical Glaciation of the Past.

In a new paper contributed to the *Quarterly Journal of the Royal Meteorological Society* (July 1926), Mr. C. E. P. Brooks once more recurs to his thesis that changes in geographical factors suffice to account for past changes in climate, devoting attention this time to the outstanding difficulty suggested by tropical glaciation at sea-level. The title of the paper is "The Meteorological Conditions during the Glaciation of the Present Tropics, being some Remarks on the Climatological Basis of Wegener's Theory of Continental Drift"; but there is really little contact with Wegener's hypothesis except in the conclusion reached that in Permo-Carboniferous times there is little doubt that glaciers reached sea-level in the lands where Wegener draws the equator, and no doubt at all that glaciers reached sea-level in the lands cut by the present equator.

Mr. Brooks follows the palæogeography of Arldt, who has reconstrueted the arrangement of land and water in the Permo-Carboniferous epoch. This reconstruction is based on the present position of the continents, discarding altogether Wegener's doubtful conjectures, and is exhibited in a map of the World on Mercator's projection. The great equatorial continent of Gondwanaland, which is the central feature of the whole discussion, embraced much of present-day Africa, extending over North-West India, Australia, and eastern South America, in all which regions there is evidence of heavy glaciation. The continent of Nearctis corresponds to much of North America, that of North Atlantis to Northern Europe and the Icelandic region, and Angaraland to Siberia, while the central sea of Tethys separated Gondwanaland from North Atlantis and Angaraland, the Volga Sea separating the two last-named land masses. Warm equatorial water poured into the northern Volga Sea, around the eastern side of Gondwanaland, giving a relatively warm climate to that region. The southern side of Gondwanaland rose abruptly from the cold

Southern Ocean, affording conditions highly favourable to the establishment of a persistent moist S.E. Monsoon. Mr. Brooks finds that, postulating certain probable initial conditions, the snow-line on Gondwanaland would be reached at 6000 feet, and as much of this equatorial continent exceeded this height extensive snow-fields would develop. The resulting glaciers no doubt could descend to sea-level if they possessed a broad enough front to carry their own cold down with them, but, as fully recognized by Mr. Brooks, the possibility of this occurring in the Tropics must depend on an exceedingly rare combination of favourable factors such as appears to have been realized only once in the history of the Earth. Among these conditions persistent cloudiness shutting out the equatorial sun would be an essential accompaniment of the monsoon wind blowing on to Gondwanaland, in addition to the heavy snowfall. One might, indeed, go a step further than Mr. Brooks, and say that for such a low snow-line as 6000 feet to occur on an equatorial continent the cloudy monsoon in question would have to prevail with something like absolute persistence, and not subject to the occasional interruptions to which even the most regular winds of the present time are liable. It is considered that all the Gondwanaland glaciers reached the southern coast except at one point on the north coast represented by the glaciation of which there is evidence in North-West India. As the Permo-Carboniferous was a time of active mountain building, it is thought probable that volcanic dust was an accessory source of cold in accordance with the demonstration of its efficacy by Prof. W. J. Humphreys of the United States.

GENERAL

The late P. P. Semenov-Tian-Shanski.

The hundredth anniversary of the birth of this Russian geographer, Gold Medallist of the Society in 1897, occurs on 14 January 1927, and as his death in 1914 was accidentally (in part no doubt owing to the outbreak of the war which speedily followed) allowed to pass without adequate notice in the *Journal*, it is fitting that something should now be said of his important services to geography during the greater part of his long life. He had long been regarded as the Doyen of Russian geographers, and besides doing valuable work in the field by his explorations in Central Asia, he was for many years the moving spirit in the Russian Geographical Society, and by the help and encouragement which he gave to younger explorers and geographers did more than any man of his time to further the cause of geography in Russia. He had been destined for a military career, but abandoned the idea in 1845 and entered the University, passing through the course in Science with distinction. In 1849 he joined the Russian Geographical Society, becoming its Librarian, and in 1850 Secretary of the Section for Physical Geography. He took a foremost part in the great undertaking of the translation into Russian of Ritter's monumental 'Geography of Asia,' and—a more difficult task—its extension by the incorporation of the large amount of new material that had accumulated since the work was first written. It was in connection with this work that he undertook his own extensive explorations of some of the least-known parts of Central Asia in the regions of the Altai and Tian Shan. Begun in 1856, they yielded a rich harvest of scientific observations. Continuing his work as editor of the Russian edition of Ritter, he became President of the Physical Geography Section of his Society in 1860, and in 1873 succeeded Von Lütke as Vice-President of the Society as a whole. Meanwhile he had undertaken the formidable task of editing a complete Gazetteer of the Russian Empire—a task brought to a successful

close in 1885. Another great undertaking, begun in 1899 when he was already seventy-two years old, was the preparation of a detailed geographical description of the Russian Empire in twenty-two volumes, of which nine had already appeared before his death.

Gilchrist Studentship.

The Gilchrist Trustees again offer, for 1927–1998, a Geography Studentship of £80, tenable at any recognized school of geography, with a view to the furtherance of improved teaching of geography in schools. Applicants, who should be teachers with at least two years' experience, should send in their names to Prof. L. W. Lyde, University College, Gower Street, W.C.1, from whom further particulars may be obtained, before 31 January 1927. They must give references and a full account of their previous work, and their applications should be accompanied by three testimonials.

Return of the Shaksgam Expedition.

During the past summer an important exploration of the Shaksgam region has been made by an expedition organized by Major Kenneth Mason, M.C., R.E., Survey of India, with the support of the Government of India and contributions of equipment, including the Wild photo-theodolite, from this Society. With Major Mason were Major H. D. Minchinton, M.C., 1st Gurkhas, Major R. C. Clifford, D.S.O., I.M.S., Captain F. O. Cave, M.C., Rifle Brigade, and Khan Sahib Afraz Gul Khan, Survey of India. The expedition has now returned to India after surveying about 2000 square miles of the Upper Shaksgam and the country north and west, and Major Mason will read a paper on the preliminary results of the expedition early in the New Year.

OBITUARY

Prof. Olinto Marinelli

GEOGRAPHY in Italy has suffered a severe loss by the premature death, on 14 June 1926, of Prof. Olinto Marinelli, one of the most zealous and active exponents of the subject in that country within recent years. Son of Giovanni Marinelli, himself a geographer of note, the deceased was born at Udine in 1874, and in 1892 accompanied his family to Florence, when his father was called to the Chair of Geography at the University there; he himself took the University course in Natural Science at that University, gaining his Doctor's degree in 1895. Even before this he had been an active collaborator in the *Rivista Geografica Italiana*, then lately founded at Rome, of which his father had soon assumed the direction; and he continued until his death one of the most regular contributors to the pages of this leading Italian geographical review, the chief direction of which he eventually assumed, after his father's death, in 1902, while he succeeded his father also in the Chair of Geography at Florence. His geographical work was not however confined to its literary and educational sides, for he travelled widely for the purpose of research, bringing home valuable results from the expedition to Eritrea carried out in association with Dainelli, and also taking an important part in De Filippi's great expedition to the Karakoram. He took broad views of the scope and aims of geography, laying stress on its twofold relation to the sciences of nature and man, and his geographical writings covered all branches of the subject. His recent work for the great Italian Atlas of the "Touring Club Italiano" deserves special mention. He had been an Hon. Corresponding Member of the R.G.S. since 1906.

Dr. Gottfried Merzbacher

The Society lost another of its Hon. Corresponding Members last year in the person of Dr. Gottfried Merzbacher, originally placed on the list in 1909 and reinstated a year ago, with others of his compatriots, after temporary removal as a result of the War. Dr. Merzbacher first came to the notice of geographers through his mountaineering ascents in the Caucasus, begun in 1891 in the central part of the range, of which accounts were sent to the Society through Mr. Freshfield. He returned to the same field in 1892, accomplishing a number of ascents in the eastern part of the range—eleven peaks over 12,000 feet were ascended—and obtaining photographs and other observations of value for the detailed mapping of the range. The results of his own explorations, combined with information collected from all available sources, were eventually given to the public in 1901 in two bulky and valuable volumes bearing the title, 'Aus den Hochregionen des Kaukasus' (reviewed in the *Journal*, vol. **18**, p. 611).

The traveller's later work was devoted to a still more remote and little-known region—The Tian Shan and neighbouring parts of Central Asia—to the detailed exploration of which he devoted himself with great energy. The Central Tian Shan was the goal of a first expedition in 1902 and 1903, the results of which appeared in German as a supplementary number of *Petermanns Mitteilungen* (149, 1904), and also in English in a volume published under the auspices of this Society. Having completed their publication he gladly seized the opportunity of returning to the same range in 1907 in company with Prince Arnulf of Bavaria, who had organized an expedition to that part of the world for the purpose of sport. On the Prince's return to Europe (where he shortly succumbed to inflammation of the lungs) Dr. Merzbacher remained in the field for a second year's work, devoting full attention to the morphology and geology of the range, and bringing back observations of no less value than those of his earlier expedition. A preliminary account of the expedition was contributed by the traveller to our *Journal* in letters written by him while still in the field, and some of the more technical observations were published by the Bavarian Academy of Sciences at Munich. As a result of his journeys Dr. Merzbacher took a recognized place as an authority on Central Asia, and from time to time contributed papers on its geography to various German geographical serials.

CORRESPONDENCE

Positions in Aïr

AT the time when Appendix I. of my book 'People of the Veil' went to press, I had not had the advantage of access to the most important 'Rapport de la Mission du Transafricain,' edited by Captain Nieger and published in Paris by the *Société d'Editions Géographiques*, etc. I should otherwise certainly have incorporated in my table of astronomical positions in Aïr and the country to the south, the positions which that expedition secured, and which are given on the various 1/400,000 sheets showing the suggested track of the proposed French Trans-African railway. The observations which I made at Teshkar (Taskr) and Guliski (Goullouski) duplicated determinations made by the French expedition with results which differ somewhat. The positions are:

		Mission Nieger.	*Rodd.*
Teshkar:	Latitude N.	.. 15° 07′ 30″	15° 07′ 40″
	Longitude E. of Gr. ..	.. 10° 43′ 23″	10° 35′ 10″
Guliski:	Latitude N.	.. 15° 01′ 50″	15° 00′ 50″
	Longitude E. of Gr. ..	.. 9° 12′ 24″	9° 06′ 20″

Part of the discrepancy is due to the different positions of observation. At Guliski, for instance, there are various points which might be taken as the site of the village; when I was there the watering-pools were extensive and numerous, and the huts of these villages are always liable to be moved from site to site within a certain area. Nevertheless I of course regard my own observations as rather tentative approximations, compared with the results which the scientific *personnel* and material made available to the Mission Nieger in its great work.

My speculations regarding the country south of the river of Agades have in part been borne out and in part supplemented by Sheet 17 of the Nieger expedition map. A few points require correction in the text of my book, notably that (pp. 66 and 74) Tateus is a rainpool and not a well.

FRANCIS RODD.

December 1926.

MEETINGS: ROYAL GEOGRAPHICAL SOCIETY: SESSION 1926–1927

First Evening Meeting, 8 November 1926.—The President in the Chair.

PAPER: The Work of the Central Asiatic Expedition in Mongolia. (The second "Asia Lecture.") Dr. Roy Chapman Andrews.

First Afternoon Meeting, 15 November 1926.—The President in the Chair.

PAPER: The East Anglian Coast. Mr. J. A. Steers.

Second Evening Meeting, 22 November 1926.—The President in the Chair.

ELECTIONS.—Hugo Addinsell; Thomas Ashton; Charles Henry Archbould Bagshaw, M.A.; Capt. Edward Beirne, A.E.C.; Capt. Jacob Percy Best; John A. Bolton; G. T. Braddock; William Richard Brunskill Briscoe, C.B.E., M.A.; Charles H. Brown; James Chapman Brown; Lieut.-Commr. William Harmer Brown, R.N.R.; Geoffrey Henry Bushby; William G. Caird; Percival Campbell; Mrs. Ada Mary Nolan Carr; Percival Richard Fenton Carter, F.R.C.I.; Mrs. Olive Murray Chapman; Major Arthur Reginald Chater, D.S.O., M.C., R.M.; Anthony Fielding Clarke, M.A.; Geoffrey Charles Cleverly; Miss G. S. Cliff; Frank Derek Corfield, B.A.; Miss Alice Gladys Cross, B.A.; Rev. Sidney John Daltry, M.A.; Eric Henry de Bunsen; Ronald de Pass; H. Peter de Silva, B.A.; Capt. John Samuel Dodd, B.A.; J. Scott Duckers; D. E. Ellepola, B.SC.; William John Ervine; Elmer J. Faucett; Prof. Pierpaolo Luzzatto Fegiz, LL.D.; Miss Christine Catherine Fellows; Frank Foley; Prof. Bernard Freeman; Miss D. Jean Garlick; Major M. L. A. Gompertz, I.A.; D. D. M. Gooneratne; Herbert Thomson Grant; James Stevenson Hall Grant; Frank Gray; Robert Scott Greenshields; William George Howard Gritten, M.A.; Charles Herbert Hamilton, O.B.E.; James Hay, M.C., B.SC., A.M.I.C.E.; D. Henry Heap; Miss Ann C. Herbertson, L.L.A.; R. Stuart Horner; Edmund Charles Thomas Horniblow, B.SC.; The Marquis Hosokawa; Capt. Bruce Humfrey, LL.B., I.A.; Frank W.

Hutchinson; Carl Jacobsen; Donald Albert Jennings, B.A.; Mrs. H. Lander Johnston, M.R.I.; George Eric Jones, B.SC.; Saravanamuttu Karthigesu, B.SC.; Frederic Keller; Prof. Watson Kirkconnell, M.A.; Arthur Kohnke; Rev. Frank D. Learner; George Martin Lees, M.C., D.F.C.; William Henry Legge; Harry Vaughan Letts; Capt. Thomas Reginald Montague Livesey, B.A., M.B.O.U.; George Lovibond; Yuko Maki; Prof. Percy Alvin Martin, M.A., PH.D.; Saburo Matsukata; H. A. Matthews, B.A.; Charles Augustus Midgley; Miss Alice Eva Marion Milnes; Miss Jean Brown Mitchell; F. E. Monk; Lieut.-Col. Philip Augustus Moore; Ralph Sisk Morgan; Miss Kate Morrison, M.B.E.; Capt. Sir Pyers G. J. Mostyn, Bart., M.C.; Mrs. Herbert Musgrave; Edward Noel Mylius; James William Naukivell; Laurence Arthur North; Edward Pape; James Parker; Rev. Harold Shepherd Perkins; William Alfred Perkins, B.A.; Miss Claudia Phelps; Leonard S. Pickard; Rev. Harold Pickles, B.A.; John Christopher Plews; A. J. Pope; Frank W. Preston, B.SC., PH.D.; Flight-Lieut. Noel Gratton Pring, R.A.F.; Peter James Pringle; George William Purves-Smith; Mrs. Lavinia Reynolds; Rev. Albert Ernest Richardson, D.D.; Rev. A. T. Richardson, M.A.; Lieut.-Col. J. Cunynghame Robertson; Lieut.-Commr. Leonard Mansfield Robinson, R.N. (Retd.); Dr. William Arasaratnam Rogers; Walter Rose; Capt. Christopher Gerald Rows, R.E.; F. C. Sands, M.B.E.; Paul de Schubert; Miss Eva Russel Scott; Eric Lord Hyde Sexton, A.B.; Dr. George Cheever Shattuck; Eden Shedden, B.A.; Lieut. Geoffrey Sherriff, R.A.; Hugh Vurnum Simmons; Lieut. Oswald Reresby Sitwell; Richard John Slader; Charles Andrew Smith; Walter Buchanan Smith, M.C.; Stephen Stagg; Capt. Graham H. Stewart; Mrs. Man Stuart; Walter Summers; Rev. Thomas Whitehead Taylor, M.A.; Lieut. E. F. Tenison; Cecil George Thorne; Fleming Voltaire Van der Byl; Reginald Arthur Wadey, B.SC.; Prof. Hachiro Watanabe; Edward Weigall; Ernest Austin Weir; Lieut. Peter Francis White, R.E.; Norman Whitehead; The Rev. Alan Williams, M.A.; Cecil Pirie Williams; Thomas B. Williams; William Washington Williams, B.A.; Samuel Wright.

PAPER: South-west Tanganyika Territory. Mr. C. Gillman.

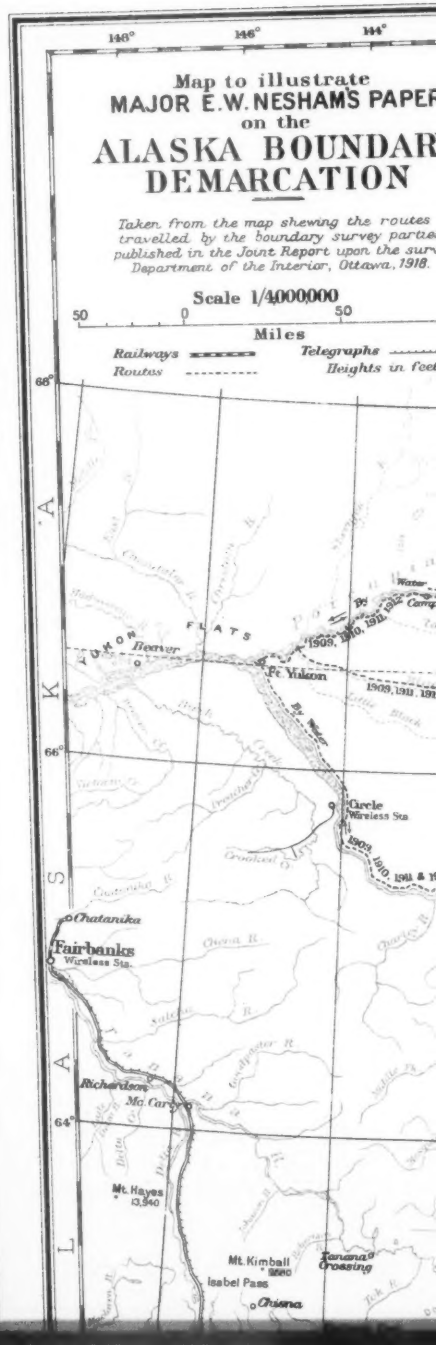
Third Evening Meeting, 6 December 1926.—The President in the Chair.

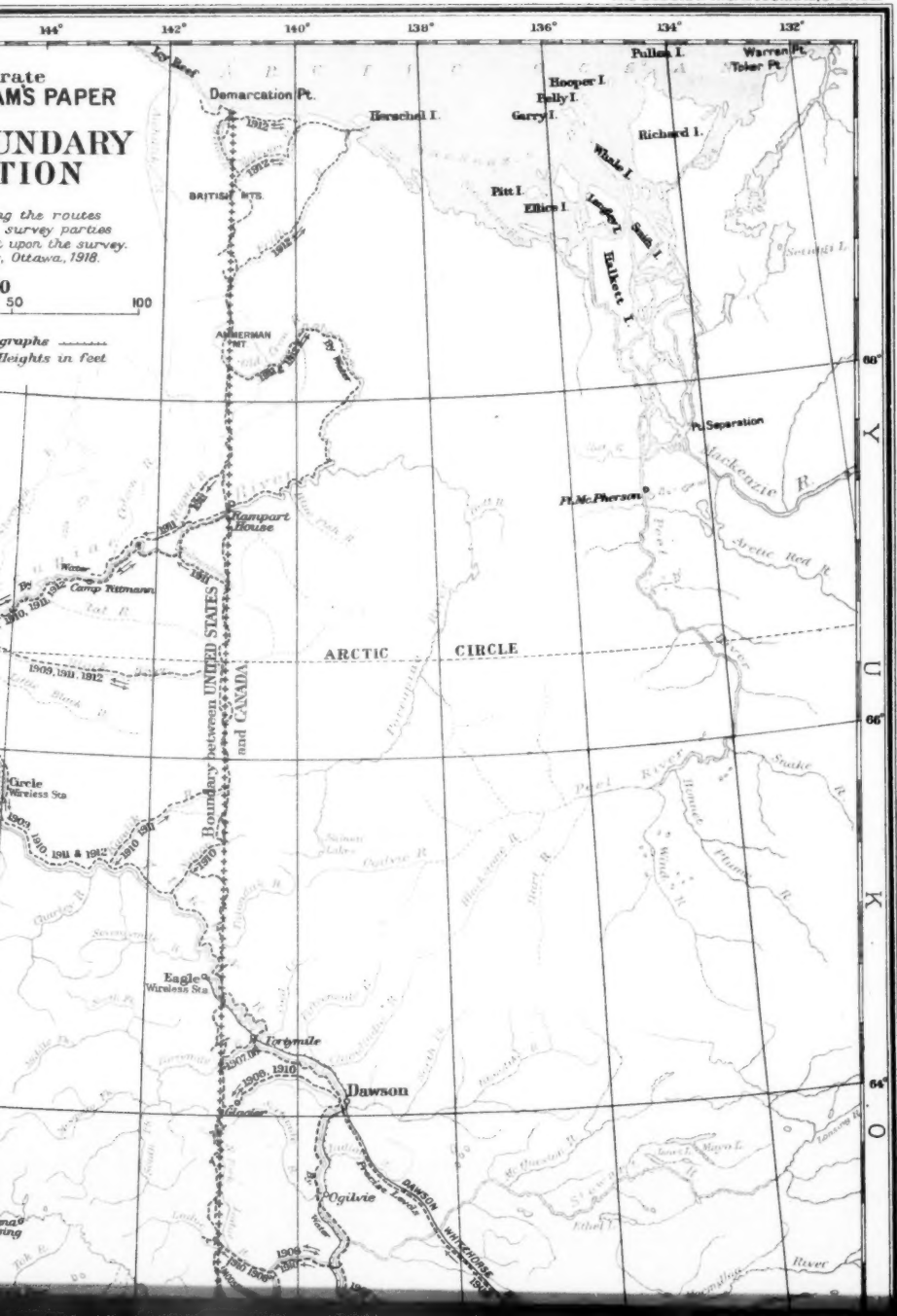
ELECTIONS.—Robert Alfred Abigail, B.A.; Charles Arthur Andrews; Major F. W. Cavendish Bentinck; William E. Brenner; Miss Bertha Cecilia Chaplin; H.I.H. The Prince Chichibu of Japan, G.C.V.O.; Mrs. Frank Dawes; C. H. Fenwick; Capt. Henry Hughes; Raja Ravisher Singh of Kalsia; Rev. Jesse R. Kellems, PH.D.; Oliver Dennis Kendall; John Frederick Knight, F.R.S.A., F.R.H.S., F.Z.S.; Lieut.-Col. Joseph Henry Levey, D.S.O., O.B.E.; Samuel Lord; Arthur Austin Miller; Jai Narain; John Joseph O'Leary; Rev. Abraham Ray; Harold Carmichael Robson; Hussein Kamil Selim, B.A.; Hubert Hoare Francis Sirr, B.A.; Lieut.-Col. G. A. J. Soltau-Symons; Mrs. Mowbray M. Spencer; Lieut.-Col. George Ashton Strutt; Joseph Swire; Francis Gordon Taylor; Capt. H. K. Turner, M.C.; John Wilfred Turner; Samitaro Uramatsu; Milton Waldman; Bertram Weaver.

PAPER: The People of the Tsangpo Gorge. Earl Cawdor.

Second Afternoon Meeting, 13 December 1926.—The President in the Chair.

PAPER: Ancient Survey Instruments. Col. Sir Henry Lyons.

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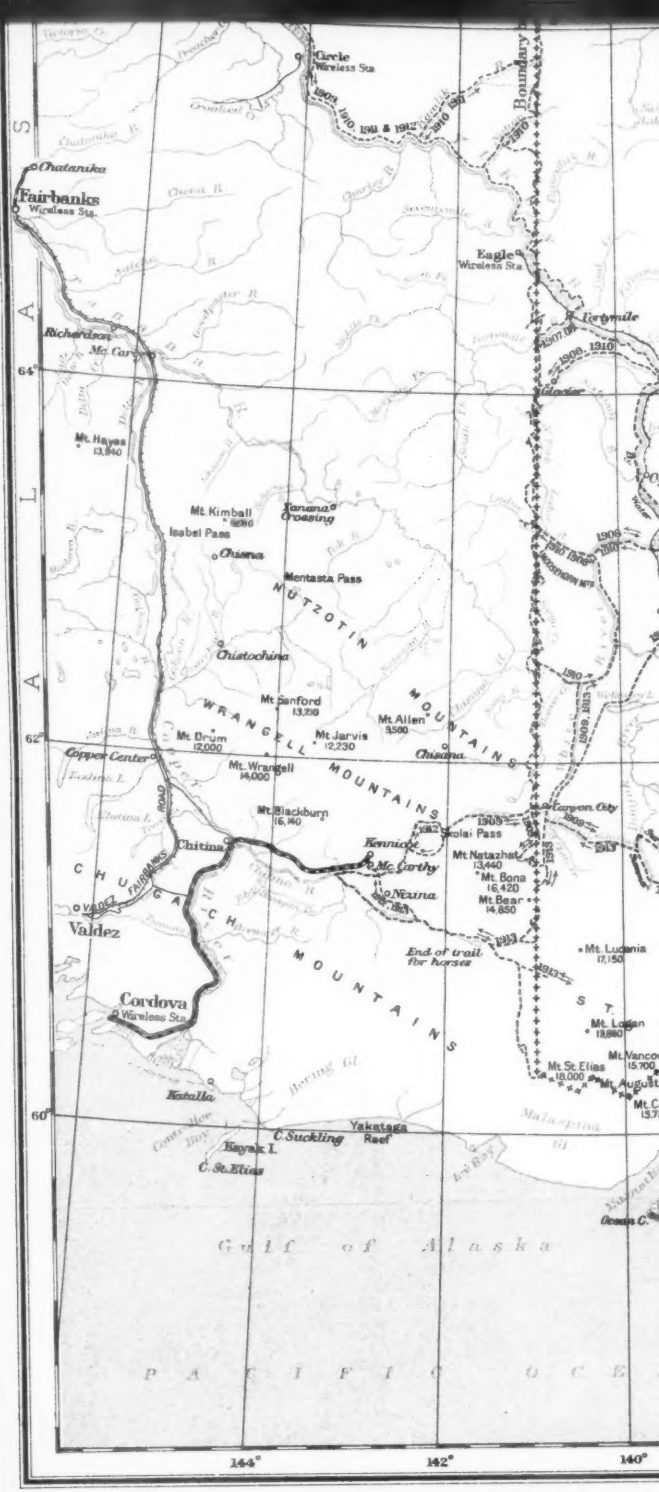

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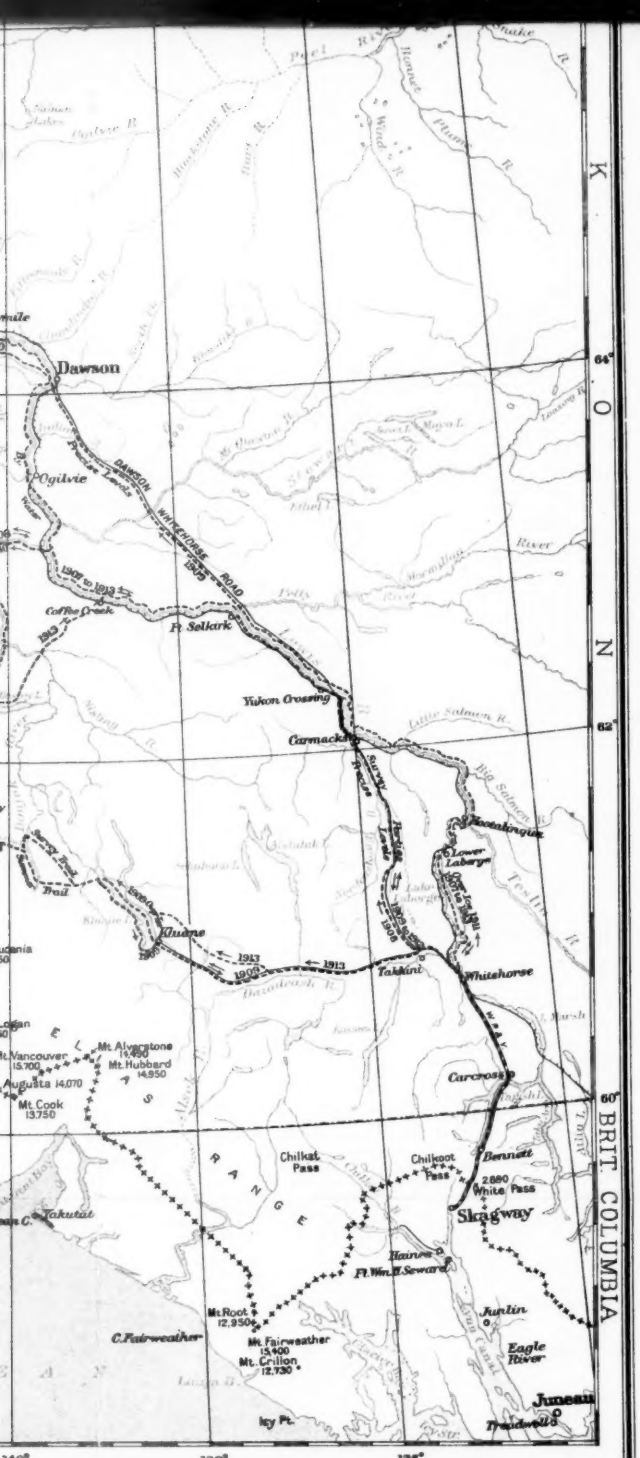

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